REPORT OF THE SECRETARY

OF THE

STATE BOARD OF AGRICULTURE

AGRICULTURAL COLLEGE, *July 1, 1908.*

TO HON. FRED M. WARNER,

Governor of the State of Michigan:

SIR—I have the honor to submit to you herewith, as required by law, the accompanying report for the fiscal year ending June 30, 1908, with supplementary papers.

Very respectfully,

ADDISON M. BROWN,

Secretary of the State Board of Agriculture.

STATE BOARD OF AGRICULTURE.

	Term expires.
ROBERT D. GRAHAM, Grand Rapids, PRESIDENT OF THE BOARD.	1911
WILLIAM H. WALLACE, Bayport,	1909
AARON P. BLISS, Saginaw,	1909
THOMAS F. MARSTON, Bay City,	1911
WILLIAM J. OBERDORFFER, Stephenson,	1911
ALFRED J. DOHERTY, Clare,	1913
I. ROY WATERBURY, Highland Station,	1913
FRED M. WARNER, GOVERNOR OF THE STATE,	*Ex-Officio.*
JONATHAN L. SNYDER, PRESIDENT OF THE COLLEGE,	*Ex-Officio.*

A. M. BROWN, Agricultural College, Secretary.
B. F. DAVIS, Lansing, Treasurer.

STANDING COMMITTEES.

The President of the Board is *ex-officio* a member of each of the Standing Committees.

BOTANY AND HORTICULTURE,	W. J. Oberdorffer, I. R. Waterbury.
BUILDINGS AND COLLEGE PROPERTY,	A. P. Bliss, A. J. Doherty.
CHEMICAL, PHYSICAL, BACTERIOLOGICAL AND OTHER DEPARTMENTS NOT OTHERWISE PROVIDED FOR,	A. P. Bliss, T. F. Marston.
EMPLOYEES,	Wm. H. Wallace, A. P. Bliss, J. L. Snyder.
ENGLISH AND MATHEMATICS,	I. R. Waterbury, T. F. Marston.
EXPERIMENT STATION,	W. J. Oberdorffer, A. P. Bliss.
FARM MANAGEMENT,	T. F. Marston, A. J. Doherty.
FINANCE,	A. J. Doherty, I. R. Waterbury.
FORESTRY,	Wm. H. Wallace, A. P. Bliss.
FARMERS' INSTITUTES,	T. F. Marston, A. J. Doherty.
LAND GRANT,	W. J. Oberdorffer, Wm. H. Wallace.
LIBRARY,	I. R. Waterbury, W. J. Oberdorffer.
MECHANICAL DEPARTMENT,	I. R. Waterbury, Wm. H. Wallace.
MILITARY AND ATHLETIC,	T. F. Marston, Wm. H. Wallace.
WOMEN'S DEPARTMENT,	A. J. Doherty, T. F. Marston.

STATE AGRICULTURAL COLLEGE.

(Under control of the State Board of Agriculture.)

FACULTY AND OTHER OFFICERS.

JONATHAN L. SNYDER, A. M., Ph. D., President; a b c Feb. 25, '96.
WM. J. BEAL, Ph. D., D. Sc., Professor of Botany; a b July 9, '70; c Sept. 1, '02.
FRANK S. KEDZIE, M. S., Professor of Chemistry; a Sept. 15, '80; b c Sept. 1, '02.
*a WILLIAM S. HOLDSWORTH, M. S., Professor of Drawing; a Feb. 22, '81; b Aug. 22, '87; c Sept. 1, '03.
LEVI R. TAFT, M. S., Superintendent of Farmers' Institutes and State Inspector of Orchards and Nurseries; a Aug. 1, '88; b c July 1, '02.
HERMAN K. VEDDER, C. E., Professor of Mathematics and Civil Engineering; a b c Sept. 15, '91.
*CLINTON D. SMITH, M. S., Dean of Short Courses, College Extension Lecturer; a b Sept. 1, '93; c July 1, '02.
WALTER B. BARROWS, B. S., Professor of Zoology and Physiology and Curator of the General Museum; a b c Feb. 15, '94.
*GEORGE A. WATERMAN, B. S., M. D. C., Professor of Veterinary Science; a b c Sept. 1, '98.
CHARLES E. MARSHALL, Ph. D., Professor of Bacteriology and Hygiene; a Sept. 1, '98; b c Sept. 1, '02.
JOSEPH A. JEFFERY, B. S. A., Professor of Agronomy and Soil Physics; a Sept. 1, '99; b c Nov. 11, '02.
MAUDE GILCHRIST, B. S., Dean of the Women's Department; a b c Sept. 1, '01.
ADDISON M. BROWN, A. B., Secretary; a b c June 1, '02.
ROBERT S. SHAW, B. S. A., Dean of Agriculture; a b Sept. 1, '02; c Jan. 15, '08.
*b ERNEST E. BOGUE, M. S., A. M., Professor of Forestry; a b c Sept. 1, '02.
ARTHUR R. SAWYER, E. E., Professor of Physics and Electrical Engineering; a b c April 11, '04.
* S. W. FLETCHER, M. S., Ph. D., Professor of Horticulture and Landscape Gardening; a b c Sept. 1, '05.
CAPT. F. W. FUEGER, U. S. A., Professor of Military Science and Tactics; a b c Sept. 1, '05.
RUFUS H. PETTIT, B. S. A., Professor of Entomology; a Jan. 1, '97; b c Sept. 1, '06.

THOMAS C. BLAISDELL, Ph. D., Professor of English Literature and Modern Languages; [a b c] Sept. 1, '06.
WILBUR O. HEDRICK, M. S., Professor of History and Political Economy; [a b] Aug. 24, '91; [c] June 20, '06.
GEORGE W. BISSELL, M. E., Dean of Engineering; [a b c] June 18, '07.
J. FRED BAKER, M. F., Professor of Forestry, Supervisor of Forest Reserve Lands.
LESLIE M. HURT, D. V. S., Professor of Veterinary Science; [a b c] Sept. 4, '07.
WARREN BABCOCK, B. S., Associate Professor of Mathematics; [a b] June 30, '91; [c] Sept. 1, '05.
E. SYLVESTER KING, Assistant Professor of English; [a] Jan. 1, '00; [b c] Sept. 1, '02.
JAMES B. DANDENO, Ph. D., Assistant Professor of Botany; [a b c] Sept. 1, '02.
LOUIS APPLEYARD, B. S., Instructor in Mechanical Engineering; [a b c] May 2, '07.
CHACE NEWMAN, Assistant Professor of Drawing; [a b] Sept. 1, '97; [c] Sept. 1, 07.
JESSE J. MYERS, B. S., Assistant Professor of Zoology; [a b] Sept. 1, 01; [c] June 26, '07.
HARRY S. REED, Assistant Professor of Chemistry; [a b] Sept. 1, '02; [c] May 2, '05.
OTTO RAHN, Ph. D., Assistant Professor of Bacteriology and Hygiene; [a] Sept., '07; [b c] May, '08.
JAMES G. HALPIN, B. S., Assistant Professor of Poultry Husbandry; [a] July, '06; [b c] May, '08.
CHARLES P. HALLIGAN, B. S., Assistant Professor of Horticulture; [a b] April 8, '07; [c] May 7, '08.
SAMUEL C. HADDEN, B. S., Assistant Professor of Mathematics and Civil Engineering; [a b] Sept., '05; [c] May 7, '08.
CARL GUNDERSON, A. M., Ph. D., Assistant Professor of Mathematics; [a b] Sept. 1, '04; [c] May 7, '08.
JOSEPH H. POLSON, B. S., Assistant Professor of Mechanical Engineering; [a b] Sept. 1, '06; [c] May 7, '08.
* WALTER G. SACKETT, B. S., Assistant Professor of Bacteriology and Hygiene; [a b] Sept. 1, '04; [c] May 2, '07.
E. H. RYDER, A. M., Assistant Professor of History and Economics; [a b] Sept. 1, '05; [c] May 2, '07.

The names of instructors whose resignations took effect between June 30 and Sept. 1, '07, do not appear below.

THOMAS GUNSON, Instructor in Horticulture and Superintendent of Grounds; [a b] April 1, '91; [c] Sept. 1, '05.
MRS. LINDA E. LANDON, Librarian; [a b c] Aug. 24, '91.
MRS. JENNIE L. K. HANER, Instructor in Domestic Art; [a b c] Sept. 1, '97.
E. C. BAKER, Foreman of Foundry; [a b c] Nov. 1, '97.
CAROLINE L. HOLT, Instructor in Drawing; [a b c] Sept. 1, '98.
LOUISE FREYHOFER, B. S., Instructor in Music; [a b c] Sept. 1, '02.
ANDREW KRENTEL, Foreman Wood Shop; [a b c] Sept. 1, '02.
H. W. NORTON, JR., B. S., Instructor in Animal Husbandry; [a b c] Sept. 1, '03.

Chester L. Brewer, B. S., Director of Physical Culture; [a b c] Sept. 1, '03.
Albert E. Jones, A. B., Instructor in Mathematics; [a b c] Sept. 15, '03.
Carl Gunderson, A. M., Ph. D., Instructor in Mathematics; [a b c] Sept. 1, '04.
Bessie Bemis, B. S., Instructor in Cookery; [a b c] Sept. 1, '05.
Norma L. Gilchrist, A. B., Instructor in English; [a b c] Sept. 1, '05.
Glenn James, A. B., Instructor in Mathematics; [a b c] Sept. 1, '05.
G. L. Stevens, A. B., Lit. B., Instructor in English; [a b c] Sept. 1, '05.
A. Crosby Anderson, B. S., Instructor in Animal Husbandry; [a b c] Sept. 1, '05.
Charles Brown, B. S., Assistant in Bacteriology; [a b c] Aug. 15, '06.
Bessie K. Paddock, B. S., Instructor in English; [a b c] Sept. 1, '06.
Erastus N. Bates, B. S., Instructor in Physics; [a b c] Sept. 1, '06.
Leslie J. Smith, B. S., Instructor in Farm Mechanics; [a b c] July 1, '06.
Grace L. Chapman, A. B., Instructor in Calisthenics; [a b c] Sept. 1, '06.
Arthur J. Clark, A. B., Instructor in Chemistry; [a b c] Sept. 1, '06.
William E. Lawrence, B. S., Instructor in Botany; [a b c] Sept. 1, '06.
* Belle Farrand, B. S., Assistant in Bacteriology; [a b c] Sept. 1, '06.
James R. Kelton, B. S., Instructor in Zoology; [a b c] Sept. 1, '06.
Wiley B. Wendt, B. C. E., Instructor in Civil Engineering; [a b c] Sept. 1, '06.
W. Lloyd Lodge, B. Sc., M. A., Instructor in Physics; [a b c] Oct. 1, '06.
F. Hobart Sanford, B. S., Instructor in Forestry; [a b c] Dec. 1, '06.
Charles W. Chapman, Instructor in Physics; [a b c] Jan. 1, '07.
Louis Appleyard, B. S., Instructor in Mechanical Engineering; [a b c] Jan. 14, '07.
William S. Sayer, B. S., Assistant in Bacteriology; [a b c] May 1, '07.
Lee Chappelle, Foreman of Machine Shop; [a b c] Sept. 1, '06.
William Holmes, Foreman of Forge Shop; [a b c] Sept. 1, '06.
* S. Alice Earl, Clerk to Secretary; [a b c] Oct. 1, '02.
Jacob Schepers, Cashier; [a b] May 1, '07; [c] July 1, '08.
Luther F. Jenison, Bookkeeper; [a b c] May 1, '07.
*Elida Yakeley, Registrar; [a] July 15, '03; [b c] June 1, '08.
* B. A. Faunce, Clerk to President and Editor M. A. C. Record; [a b c] Sept. 1, '04.
L. F. Newell, Engineer; [a b c] Jan. 1, '98.
E. A. Bowd, Architect; [a b c] Jan. 1, '02.
Rowena Ketchum, in charge of College Hospital; [a b c] Sept. 1, '00.
* Cora L. Feldkamp, B. S., Assistant Librarian; [a b c] Sept. 1, '05.
Frank William Howe, B. S., A. B., Instructor in Agriculture; [a b c] Aug. 1, '07.
Pearl MacDonald, M. A., Instructor in Domestic Science; [a b c] Sept. 1, '07.
August C. Mehrtens, M. E., Instructor in Mechanical Engineering; [a c b] Sept. 1, '07.
Orestes I. Gregg, B. S., Instructor in Horticulture; [a b c] Sept. 1, '07.
Mrs. Minnie Hendricks, A. M., Instructor in History; [a b c] Sept. 1, '07.
Wallace B. Liverance, B. S., Instructor in Dairying; [a b c] Sept. 1, '07.
* Frank M. Boyles, B. S., Instructor in Chemistry; [a b c] Sept. 1, '07.
J. Ferris Darling, B. S., Instructor in Chemistry; [a b c] Sept. 1, '07.
Chas. H. Harper, B. S., Instructor in Drawing; [a b c] Sept. 1, '07.

WM. H. PERKINS, Instructor in Drawing; [a b c] Sept. 1, '07.
W. RODNEY CORNELL, B. S., Instructor in Civil Engineering; [a b c] Sept. 1, '07.
J. TERENCE MCVEY, C. E., Instructor in Civil Engineering; [a b c] Sept. 1, '07.
FRANK G. TOMPKINS, A. B., Instructor in English; [a b c] Sept. 1, '07.
WM. A. ROBINSON, A. B., S. T. B., Instructor in English; [a b c] Sept. 1, '07.
WALTER H. WADLEIGH, A. B., Instructor in English; [a b c] Sept. 1, '07.
ZENO P. METCALF, B. S., Instructor in Entomology; [a b c] Sept. 1, '07.
G. ARTHUR HEINRICH, B. S., Instructor in Mathematics; [a b c] Sept. 1, '07.
CARL C. WILCOX, M. E., E. E., Instructor in Machine Shop; [a b c] Oct. 1, '07.

FACULTY AND OTHER OFFICERS.

CARL E. MCALVAY, A. M., Instructor in History and Economics; [a b c] Jan. 1, '08.
JOHN C. PALTRIDGE, A. B., Instructor in English; [a b c] Jan. 1, '08.
LESLIE M. CULLOM, A. M., Instructor in English; [a b c] Jan. 1, '08.
CHAS. A. PIERCE, B. S., Instructor in Mathematics; [a b c] Nov. 15, '07.
ROSE M. TAYLOR, A. B., Instructor in Botany; [a b c] Feb. 8, '08.
FLORENCE M. ROUNDS, B. S., Instructor in Drawing; [a b c] Sept. 1, '07.
ANDY ANDERSON, Assistant in Farm Mechanics; [a b c] Sept. 1, '06.
WILLIAM J. WRIGHT, B. S., Clerk to President and Editor M. A. C. Record; [a b c] Aug. 1, '07.
AGNES E. CRUMB, Assistant Librarian; [a] Aug. 12, '08; [b c] Mar. 1, '08.
RALPH S. HUDSON, B. S., Foreman College Farm; [a b c] Dec. 1, '07.
MAUD A. MEECH, Clerk to Secretary; [a b c] April 1, '08.
LEON GINTER, Bulletin Clerk; [a b c] June 15, '07.

a First appointment.
b Present appointment
c Present title.
* Resigned.
*a Died Sept. 18, 1907.
*b Died Aug. 19, 1907.

AGRICULTURAL EXPERIMENT STATION

OF THE

MICHIGAN AGRICULTURAL COLLEGE

(Under the control of the State Board of Agriculture.)

STATION COUNCIL.

J. L. SNYDER, M. A., Ph. D., Pres., *Ex-officio* Member.
ROBERT S. SHAW, B. S. A., } - Director.
*CLINTON D. SMITH, M. S., } - Director.
L. R. TAFT, M. S., - Horticulturist.
R. H. PETTIT, B. S. A., - Entomologist.
A. J. PATTEN, B. S., - - Chemist.
CHAS. E. MARSHALL, Ph. D., Scientific and Vice Director, Bacteriologist and Hygienist.
A. M. BROWN, A. B., - Sec. and Treas.

ADVISORY AND ASSISTANT STAFF.

S. W. FLETCHER, M. S., Ph. D., Associate Horticulturist.
*GEO. A. WATERMAN, V. S., M. D. C., Consulting Veterinarian.
LESLIE M. HURT, D. V. S., Consulting Veterinarian.
MRS. L. E. LANDON, - - Librarian.
*W. G. SACKETT, B. S., Research Asst. in Bacteriology and Hygiene.
OTTO RAHN, Ph. D., Research Asst. in Bacteriology and Hygiene.
WILLIAM S. SAYER, B. S., Research Asst. in Bacteriology and Hygiene.
CHARLES BROWN, B. S., Research Asst. in Bacteriology and Hygiene.
L. JODIDI, Ph. D., Research Asst. in Chemistry.
CHAS. P. HALLIGAN, B. S., Assistant Horticulturist.
LEO M. GEISMAR, Chatham, In Charge of Upper Peninsula Exp'm't Station.
F. A. WILKEN, - In Charge of South Haven Sub-Station.
*BELL FARRAND, B. S., Asst. in Bacteriology.
LULU SMITH, B. S., Asst. in Bacteriology.

SUB-STATIONS.

Grayling, Crawford County, 80 acres deeded.
South Haven, Van Buren County, 10 acres rented; 5 acres deeded. Local agent, F. A. Wilken.
Chatham, Alger County, 160 acres deeded. Local agent, Leo M. Geismar.

STANDING COMMITTEE IN CHARGE.

HON. WM. J. OBERDORFFER, - - - - - - - Stephenson.
HON. A. P. BLISS, - - - - - - - - - Saginaw.

STATE WEATHER SERVICE.

(Under control of the State Board of Agriculture.)

C. F. SCHNEIDER, Director U. S. Weather Bureau - - - Grand Rapids.

* Resigned.

ACCOUNTS OF THE STATE AGRICULTURAL COLLEGE.

FOR THE YEAR ENDING JUNE 30, 1908.

SECRETARY'S FINANCIAL REPORT.

			Dr.	Cr.
July 1, 1907.	To cash on deposit, college treasurer		$15,797 72	
July 1, 1907.	To cash on hand		3,802 62	
June 30, 1908.	To special appropriation receipts		85,355 84	
	From State Treasurer	$55,310 00		
	From United States Treasurer	23,326 10		
	From institution and other sources	6,719 74		
June 30, 1908.	By special appropriation disbursements			$77,150 44
June 30, 1908.	To current account receipts		280,248 45	
	From State Treasurer, land grant interest	$70,385 79		
	From State Treasurer, one-tenth mill tax	112,820 00		
	From U. S. Treasurer, Morrill fund	30,000 00		
	From institution and other sources	64,728 72		
	From South Haven Experiment Station.	343 53		
	From Upper Peninsula Experiment Station	1,970 41		
	By general account disbursement			281,991 91
	From current account	$264,625 94		
	From supplementary accounts	17,365 97		
June 30, 1908.	By cash on hand			2,229 95
June 30, 1908.	By cash on deposit			23,832 33
			$385,204 63	$385,204 63

TABLE No. 1.—*Tabular exhibit of secretary's report.*

	Balance sheet July 1, 1907.		Transactions, July 1, 1907, to June 30, 1908.		Balance sheet June 30, 1908.	
	Dr.	Cr.	Dr.	Cr.	Dr.	Cr.
Cash	$3,802 62		$1,572 67		$2,229 95	
College treasurer*	15,797 72			$8,034 61	23,832 33	
Special appropriations		$7,203 47	85,355 84	77,150 44		$15,408 87
Current accounts		12,396 87	277,934 51	264,625 94		10,653 41
Supplementary accounts			2,313 94	17,365 97		
Totals	$19,600 34	$19,600 34	$367,176 96	$367,176 96	$26,062 28	$26,062 28

* Treasurer's statement is greater July 1, 1907, by $14,719.83 and June 30, 1908, by $3,120.16; warrants outstanding.

TREASURER'S ACCOUNT.

	Dr.	Cr.
Balance on hand July 1, 1907	$30,517 55	
Receipts from State Treasurer and secretary of college	366,599 24	
Interests on deposits 12 months at 2½ per cent	583 93	
Warrants paid July 1, 1907, to June 30, 1908		$370,748 23
Balance on June 30, 1908		26,952 49
Total	$397,700 72	$397,700 72

TABLE NO. 2.—*Statement of special appropriation account for fiscal year July 1, 1907, to June 30, 1908.*

Name of appropriation.	Balance of accounts, July 1, 1907.		Receipts during fiscal year.		Total available.	Total expended.	Balance of account, June 30, 1908.	
	Dr.	Cr.	From State treasury.	From institution and other sources.			Dr.	Cr.
Experiment Station	....	$314 53	*$23,326 10	$5,122 85	$28,763 48	$28,605 53	....	$157 95
Nursery License and Inspection	....	....	....	1,098 97	1,098 97	1,098 97	....	....
Sundry Improvements	....	774 49	8,310 00	3 00	9,087 49	6,942 22	....	2,145 18
Agricultural Building	....	....	5,000 00	....	5,000 00	501 91	....	4,498 09
Engineering Building	....	4,049 96	15,000 00	7 02	19,047 98	19,047 98		
Live Stock Special, 1905	....	27 12			27 12	27 12	....	....
Live Stock Special, 1907	....	....	20,000 00	323 70	20,323 70	15,149 16	....	5,174 54
Live Stock Special, Poultry	....	....	6,000 00	2 75	6,002 75	3,983 10	....	2,019 65
Semi-Centennial	....	1,567 43	....	161 45	1,728 88	315 23	....	1,413 65
U. P. Experiment Station, Special	....	430 13	....		430 13	430 13	....	....
Weather Bureau		48 99	1,000 00	....	1,048 90	1,049 09	$19 00	....
Balance	$7,293 47	....	....	....	....	....	15,408 87	....
Total	$7,293 47	$7,293 47	$78,636 10	$6,719 74	$92,559 31	$77,150 44	$15,409 06	$15,409 06

* U. S. Treasurer.

TABLE NO. 3.—*Current account July 1, 1907, to June 30, 1908.*

On account of—	Dr. To disbursements.	Cr. By Receipts.
U. S. Treasurer, 18th annual payment under act of congress of August 30, 1890	....	$30,000
State Treasurer, one-tenth mill tax	....	112,820
State Treasurer, interest on proceeds of sales of U. S. land grant	....	70,385
Salaries	$100,168 41	1,270
Farm department	17,191 41	12,734
Horticultural department	6,608 79	2,613
Mechanical department	21,317 00	1,654
Heating department	21,804 96	466
Cleaning department	2,577 95	168
Electric lighting department	5,520 89	2,500
Office	2,360 28	202
Advertising	1,832 33	89
M. A. C. Record	1,371 14	638
Special courses	4,701 30	2,775
Academic departments	224,793 55	6,059
Contingent building	31,553 04	28,732
Miscellaneous	3,686 24	2,828
Women's	2,727 59	1,749
Telephones	1,372 22	245
Total	$264,625 94	$277,933
Supplementary accounts:		
Bulletins	2,959 44	....
Farmers' institutes	8,468 24	
South Haven experiment station	2,188 73	343
Upper Peninsula experiment station	3,749 56	1,970
Balance at beginning of period July 1, 1907	....	12,396
Balance at close of period June 30, 1908	10,653 41	....
Total	$292,645 32	$292,645

TABLE NO. 4.—*Experiment station account, July 1, 1907, to June 30, 1908.*

On account of—	Dr. To disbursements.	Cr. By receipts.
Balance from fiscal year July 1, 1907	....	$314
U. S. Treasurer for fiscal year	....	23,326
Bacteriological department	$3,089 38	1,101
Botanical department	66 80	....
Chemical department	3,144 89	58
Director's office	846 56	14
Entomological department	1,692 97	....
Farm department	4,088 43	462
Fertilizer license fees	85 00	3,215
Horticultural department	1,782 57	4
Library	596 51	3
Live stock	355 11	....
Salaries	11,419 32	260
Secretary's office	460 42	1
Sundry	16 50	....
Veterinary	961 07	....
Balance on hand June 30, 1908	157 95	....
Total	$28,763 48	$28,763

TABLE No. 5.—*Regular employees and salaries.*

Grade.	Rate per year.	Classification. Current.	Classification. Experim't station.	Other sources.	
resident's office.					
President	$5,000 00	$5,000 00			House.
Clerk	1,000 00	1,000 00			
Clerk	500 00	500 00			
Agricultural Dept.					
Dean	2,400 00	2,000 00	$400 00		House.
Professor of Agronomy	2,000 00	2,000 00			
Instructor Animal Husbandry	1,350 00	1,350 00			
Instructor Animal Husbandry	1,350 00	1,350 00			
Instructor Dairying	660 00	660 00			
Instructor Agriculture	800 00	800 00			
Instructor Poultry Husbandry	1,200 00	1,200 00			
Instructor Farm Mechanics	1,000 00	1,000 00			
Instructor Blacksmithing	660 00	660 00			
Foreman College Farm	600 00	600 00			
Clerk, Farm Department	600 00	600 00			
acteriological Dept.					
Professor	2,300 00	1,300 00	1,000 00		
Assistant Professor	1,400 00	1,250 00	150 00		
Instructor	500 00	500 00			
Instructor	600 00	600 00			
Instructor	1,200 00		1,200 00		
Instructor	500 00		500 00		
Instructor	1,000 00		1,000 00		
otanical Dept.					
Professor	2,000 00	2,000 00			House.
Assistant Professor	1,200 00	1,200 00			
Instructor	800 00	800 00			
Instructor	700 00	700 00			
hemical Dept.					
Professor	2,300 00	2,300 00			
Assistant Professor	1,200 00	1,200 00			
Instructor	1,000 00	1,000 00			
Instructor	800 00	800 00			
Chemist Experiment Station	1,800 00		1,800 00		
Asst. Chemist Experiment Station	1,200 00		1,200 00		
rawing.					
Assistant Professor	1,200 00	1,200 00			
Instructor Mechanical Drawing	700 00	700 00			
Instructor Mechanical Drawing	650 00	650 00			
Instructor Mechanical Drawing	700 00	700 00			
Instructor Drawing	800 00	800 00			
nglish Dept.					
Professor	2,000 00	2,000 00			House.
Assistant Professor	1,050 00	1,050 00			Rooms.
Instructor	700 00	700 00			
Instructor	750 00	750 00			
Instructor	900 00	900 00			
Instructor	600 00	600 00			
Instructor	840 00	840 00			
Instructor	900 00	900 00			
ntomological Dept.					
Professor	1,600 00	1,000 00	600 00		House.
Instructor	700 00	350 00	350 00		
orestry Dept.					
Professor	2,000 00	2,000 00			
Instructor	1,000 00	1,000 00			
orticultural Dept.					
Professor	2,300 00	2,300 00			
Assistant Professor	1,200 00	800 00	400 00		
Instructor	1,200 00	1,200 00			
Instructor	700 00	700 00			House.
Foreman of grounds	600 00	600 00			House.

TABLE No. 5.—*Concluded.*

Grade.	Rate per year.	Classification.		Other sources.	
		Current.	Experim't station.		
History and Pol. Economy Dept.					
Professor	$1,900 00	$1,900 00	....	....	....
Instructor	1,200 00	1,200 00	....	....	....
Instructor	900 00	900 00	....	....	....
Instructor	700 00	700 00	....	....	....
Institute and Nursery Inspector.					
Superintendent	2,000 00	1,400 00	$600 00	....	House.
Library Dept.					
Librarian	1,000 00	880 00	120 00	....	Rooms.
Assistant Librarian	500 00	500 00	....	....	....
Mathematical Dept.					
Professor	2,000 00	2,000 00	....	....	House.
Associate Professor	1,850 00	1,850 00	....	....	Rooms.
Instructor Civil Engineering	1,200 00	1,200 00	....	....	....
Instructor Civil Engineering	800 00	800 00	....	....	....
Instructor Civil Engineering	700 00	700 00	....	....	....
Instructor Civil Engineering	750 00	750 00	....	....	....
Instructor Mathematics	900 00	900 00	....	....	....
Instructor Mathematics	800 00	800 00	....	....	....
Instructor Mathematics	700 00	700 00	....	....	....
Instructor Mathematics	700 00	700 00	....	....	....
Instructor Mathematics	650 00	650 00	....	....	....
Mechanical Dept.					
Dean	2,400 00	2,400 00	....	....	House.
Assistant Professor	1,400 00	1,400 00	....	....	....
Instructor	1,200 00	1,200 00	....	....	....
Instructor	750 00	750 00	....	....	....
Instructor in Forge Shop	800 00	800 00	....	....	....
Foreman Machine Shop	800 00	800 00	....	....	....
Foreman Woodshop	900 00	900 00	....	....	....
Foreman Foundry	800 00	800 00	....	....	....
Clerk	540 00	540 00	....	....	....
Miscellaneous.					
Dean Short Courses	2,200 00	400 00	1,800 00	....	House.
Architect	1,500 00	1,500 00	....	....	....
Engineer	1,200 00	1,200 00	....	....	....
Plumber	900 00	900 00	....	....	....
Night Watchman	480 00	480 00	....	....	....
Nurse	450 00	450 00	....	....	....
Dept. of Physics.					
Professor	2,300 00	2,300 00	....	....	....
Instructor	1,100 00	1,100 00	....	....	....
Instructor	800 00	800 00	....	....	....
Instructor	900 00	900 00	....	....	....
Instructor	800 00	800 00	....	....	....
Secretary's Office.					
Secretary	2,000 00	300 00	700 00	$1,000 00	House.
Cashier	1,200 00	1,000 00	200 00	....	....
Bookkeeper	700 00	600 00	100 00	....	....
Clerk	500 00	375 00	125 00	....	....
Bulletin Clerk	550 00	....	550 00	....	....
Veterinary Dept.					
Professor	2,000 00	1,700 00	300 00	....	....
Women's Dept.					
Dean	1,500 00	1,500 00	....	....	Rooms.
Instructor Sewing	600 00	600 00	....	....	Rooms.
Instructor Domestic Science	800 00	800 00	....	....	Rooms.
Instructor Physical Culture	600 00	600 00	....	....	Rooms.
Instructor Music	950 00	950 00	....	....	....
Instructor Cooking	600 00	600 00	....	....	Rooms.
Instructor Sewing	360 00	360 00	....	....	....
Zoological Dept.					
Professor	2,000 00	2,000 00	....	....	....
Assistant Professor	1,200 00	1,200 00	....	....	....
Instructor	700 00	700 00	....	....	....
Total	$120,440 00	$106,345 00	$13,095 00	$1,000 00	....

TABLE No. 6.—*Income of the State Agricultural College from all outside sources from the date of its foundation to the present time.*

Year.	From State Legislature.			From U. S. Congress.			Total.
	For current expenses.	For special purposes.	Land sales, salt spring and swamp land grants.	Morrill act of 1862, interest from land grant and trespass.	Hatch act of 1887, and Adams act of 1906, experiment station.	Morrill act of 1890, supplementary endowment.	
1855...	....	....	$56,320 00	....	....	....	$56,320 00
1856...	....	....	....	....	....	....	....
1857...	$40,000 00	....	....	....	....	....	40,000 00
1858...	....	....	....	....	....	....	....
1859...	37,500 00	....	....	....	....	....	37,500 00
1860...	....	....	....	....	....	....	....
1861...	6,500 00	....	152 25	....	....	....	6,652 25
1862...	10,000 00	....	218 97	....	....	....	10,218 97
1863...	9,000 00	....	407 80	....	....	....	9,407 80
1864...	9,000 00	....	726 09	....	....	....	9,726 09
1865...	15,000 00	....	1,156 61	....	....	....	16,156 61
1866...	15,000 00	....	1,094 27	....	....	....	16,094 27
1867...	20,000 00	....	7,608 38	....	....	....	27,608 38
1868...	20,000 00	....	592 49	....	....	....	20,592 49
1869...	20,000 00	$30,000 00	17,559 00	$58 96	....	....	67,617 96
1870...	20,000 00	....	1,320 02	2,720 93	....	....	24,040 95
1871...	18,250 00	10,500 00	4,135 72	3,785 54	....	....	36,671 26
1872...	18,250 00	3,000 00	217 05	7,175 65	....	....	28,642 70
1873...	21,796 00	15,602 00	10 13	11,059 06	....	....	48,467 19
1874...	13,000 00	15,602 00	150 13	14,061 98	....	....	42,814 11
1875...	7,638 00	7,755 50	144 53	14,446 14	....	....	29,984 17
1876...	7,638 00	6,755 50	1,773 09	16,830 17	....	....	32,996 76
1877...	6,150 00	30,686 80	979 06	15,172 86	....	....	52,988 72
1878...	6,150 00	5,686 80	826 60	15,807 09	....	....	28,470 49
1879...	4,971 80	16,068 32	712 22	16,978 22	....	....	38,730 56
1880...	4,971 80	7,068 32	797 55	17,837 24	....	....	30,674 91
1881...	7,249 00	43,729 50	461 95	20,935 25	....	....	72,366 70
1882...	7,249 00	8,945 50	358 46	22,507 45	....	....	39,060 41
1883...	8,385 00	23,793 00	391 95	30,749 60	....	....	63,319 55
1884...	8,385 00	10,526 00	1,259 90	27,909 72	....	....	48,080 62
1885...	....	35,103 00	187 50	29,770 40	....	....	65,060 90
1886...	....	22,617 00	....	30,461 04	....	....	53,078 04
1887...	....	*44,040 00	198 20	†24,611 37	....	....	68,849 57
1888...	....	30,752 50	144 20	32,406 60	$15,000 00	....	78,303 30
1889...	....	*20,973 00	10 50	31,322 69	15,000 00	....	67,306 19
1890...	....	*27,172 00	238 50	32,360 64	15,000 00	$15,000 00	89,771 14
1891...	....	22,947 50	37 38	34,750 54	15,000 00	16,000 00	88,735 42
1892...	....	22,947 50	137 38	34,948 12	15,000 00	17,000 00	90,033 00
1893...	....	18,862 50	10 50	37,927 04	15,000 00	18,000 00	89,800 04
1894...	....	18,862 50	433 59	44,527 26	15,000 00	19,000 00	97,823 35
1895...	....	‡19,000 00	10 50	45,301 85	15,000 00	20,000 00	99,312 35
1896...	....	‡16,000 00	....	43,886 40	15,000 00	21,000 00	95,886 40
1897...	....	§17,700 00	....	43,779 54	15,000 00	22,000 00	98,479 54
1898...	....	‖17,500 00	....	47,508 28	15,000 00	23,000 00	103,008 28
1899...	....	¶8,750 00	705 00	52,526 11	15,000 00	24,000 00	100,981 11
1900...	....	¶72,500 00	175 00	72,298 38	15,000 00	25,000 00	184,973 38
1901††.	....	¶72,500 00	....	63,976 79	15,000 00	25,000 00	176,476 79
1902...	100,000 00	**1,000 00	....	64,081 81	15,000 00	25,000 00	205,081 81
1903...	100,000 00	**1,000 00	....	65,573 90	15,000 00	25,000 00	206,573 90
1904...	100,000 00	**1,000 00	61 19	67,312 37	15,000 00	25,000 00	208,373 50
1905...	100,000 00	*81,000 00	....	72,035 32	15,000 00	25,000 00	293,035 32
1906...	157,810 00	*15,000 00	....	70,286 56	15,000 00	25,000 00	284,096 56
1907...	173,410 00	**1,000 00	....	70,155 22	23,691 60	25,000 00	293,256 82
1908...	173,410 00	**1,000 00	....	70,385 79	23,326 10	30,000 00	298,121 89
Totals..	$1266713 60	$824,937 74	$101,723 66	$1420,229 88	$332,017 70	$425,000 00	$4370,622 58

*Including appropriation for weather service.
†October 1, 1886, to June 30, 1887, nine months.
‡Including $5,000 for institutes and $1,000 for weather service.
¶Including $5,500 for institutes and $1,000 for weather service.
‖Including $5,500 for institutes and $1,000 for weather service.
§Including $2,750 for institutes and $500 for weather service.
††To June 30. **Weather service.

SUMMARY OF INVENTORY, JUNE 30, 1908.

College farm and park, 671 acres		$46,970 00
Athletic field and drive, 13 acres		1,137 50
Buildings—		
Library and museum, built 1881	$22,000 00	
College hall, built 1856	17,000 00	
Wells Hall, rebuilt 1905–06	55,000 00	
Williams Hall, built in 1869	30,000 00	
Abbott Hall, built 1888, addition in 1896	15,000 00	
Chemical laboratory, built 1871, south end addition 1881	18,000 00	
Machine shops and foundry, 1885, south end add. 1887	15,000 00	
Veterinary laboratory, built 1885	5,000 00	
Horticultural laboratory, built 1888	7,000 00	
Agricultural laboratory, built 1889, imp. 1897	7,500 00	
Botanical laboratory, built 1892	10,000 00	
Armory, built 1885	6,000 00	
Greenhouse and stable, built 1873, 1879, rebuilt 1892 and 1902	6,000 00	
Boiler house and chimney, built 1893–4	3,000 00	
President's and two frame dwellings, built 1874	12,000 00	
Six brick dwellings, built 1857, 1879 and 1884	18,000 00	
One frame house, built 1885	3,500 00	
Howard Terrace dwelling, built 1888	13,000 00	
Farm house dwelling, built 1869	2,000 00	
Herdsman's dwelling, built 1867	400 00	
Six barns at professors' houses	1,050 00	
Horticultural barn and shed, built 1868, 1875 and 1877	1,200 00	
Bull barn, rebuilt 1905	1,500 00	
Sheep barn, rebuilt 1906	2,500 00	
Horse barn, built 1906	5,000 00	
Grade herd barn, rebuilt 1905	4,000 00	
Piggery, rebuilt 1907	1,500 00	
Dairy barn, rebuilt 1900	4,000 00	
Farm mechanics building, built 1881	1,500 00	
Poultry house, built 1906	1,000 00	
Incubator house, built 1906	500 00	
Poultry house, built 1907	1,500 00	
Three poultry houses, built 1907	300 00	
Ten brooder houses, built 1908	250 00	
Corn barn, built 1878	400 00	
Stock judging barn, built 1894	200 00	
Brick work shop, built 1857	500 00	
Observatory, built 1880	100 00	
Bath house and fittings, built 1902–3	17,000 00	
Paint shop, rebuilt 1903	150 00	
Hospital, built 1894	3,000 00	
Post office and waiting room, built 1902	1,700 00	
Lumber shed, mechanical department	250 00	
Three silos	600 00	
Coal shed, built 1899	700 00	
Women's building, built 1900	91,000 00	
Dairy building, built 1900	15,000 00	
Bacteriological building, built 1902	27,000 00	
Power house, built 1904	25,000 00	
Coal shed, built 1905	6,500 00	
Tunnel system, built 1904	45,000 00	
Cold storage, rebuilt 1905	2,000 00	
Engineering building, built 1906–07, including heating	110,000 00	
Amount carried forward	$637,299 50	$48,107 50

Amount brought forward	$637,299 50	$48,107 50
Iron bridge over Cedar river, built 1888	1,500 00	
Bridge to athletic field	500 00	
Manure shed	600 00	
		639,899 50
Heat, Light and Water Department—		
Steam heating plant	$17,577 00	
Bath house plant	698 00	
Water works plant	12,760 00	
Telephones	2,000 00	
Electric light department	8,658 10	
Tools and fixtures, steam and water	1,536 54	
Stock	93 71	
Electric light stock	1,269 44	
Plumbing stock	549 77	
		45,142 56
Bacteriological Department—		
Literature	$75 38	
College chemicals	848 65	
College apparatus	7,127 53	
College fixtures	1,210 45	
		9,262 01
Botanical Department—		
Herbarium	$1,871 42	
Museum	845 60	
Books	806 92	
Negatives	239 58	
Photos and engravings	943 05	
Lantern slides	263 24	
Microscopes and accessories	1,847 67	
Glassware, etc	565 23	
Chemicals	71 82	
Office and classroom equipment	799 42	
General equipment	194 97	
Garden tools	55 06	
		8,503 98
Chemical Department—		
Cases and fixtures	$3,310 60	
Electric	1,267 70	
Platinum	2,367 57	
Graduated glassware	1,162 36	
Ungraduated glassware	3,863 49	
Organic chemicals	319 47	
Inorganic chemicals	705 76	
Balances	1,743 00	
Weights	668 95	
Mercury	28 33	
Special apparatus	1,886 95	
Rubber	72 50	
Specimens	497 85	
Metals	48 65	
Hardware	977 37	
Tools	57 15	
Assay room supplies	187 42	
Porcelain	813 80	
Wooden	112 23	
Miscellaneous	272 80	
		20,363 95
Farm Department—		
Agronomy division	$2,384 33	
Farm mechanics	3,644 22	
Live stock, swine	1,327 50	
Live stock, horses	5,750 00	
Amount carried forward	$13,106 05	$771,279 50

Amount brought forward	$13,106 05	$771,279 50
Farm Department—Continued.		
Live stock, cattle	$12,286 00	
Live stock, sheep	3,718 00	
Grade herd barn	34 85	
Dairy barn	66 25	
Bull barn	12 35	
Sheep barn	61 60	
Tool barn	1,542 99	
Horse barn	302 35	
Poultry	918 20	
Dairy	1,294 11	
Meat house	126 85	
Office library	1,705 41	
Office	568 26	
		35,743 27
Horticultural Department—		
Heavy tools	$546 00	
Teams and harnesses	676 50	
Miscellaneous	560 45	
Greenhouse tools	286 94	
Zoo	112 00	
Greenhouse plants	1,581 15	
Office	2,004 79	
Classroom	522 36	
Laboratory equipment	440 25	
Tools	283 50	
		7,013 94
Mathematical Department—		
Transits	$2,659 30	
Levels	1,504 35	
Sextants	245 25	
Miscellaneous surveying instruments	476 73	
Plumb bobs	19 56	
Apparatus	1,090 53	
Tools	34 65	
Drawing instruments and materials	204 65	
Books and pamphlets	275 03	
Photographic material	58 25	
Astronomical laboratory	838 50	
Abbot Hall classrooms	54 00	
Room 8 College Hall	36 50	
Compasses	469 80	
Room 2 College Hall	372 15	
Offices 104 and 105 Engineering Hall	720 93	
Office 110 Engineering Hall	211 00	
Office Room 202 Engineering Hall	417 70	
Office Room 108 Engineering Hall	94 70	
Room 106 Engineering Hall	605 32	
Room 107 Engineering Hall	273 80	
Hydraulic laboratory	325 83	
Room 404 Engineering Hall	205 00	
Room 401 Engineering Hall	18 70	
Classroom 304 Engineering Hall	498 58	
Classroom 306 Engineering Hall	506 98	
Classroom 302 Engineering Hall	30 80	
Classroom 203 Engineering Hall	30 80	
Office 305 Engineering Hall	199 82	
Rods and poles	412 22	
Tapes and chains	355 64	
		13,247 07
Amount carried forward		$827,283 78

Amount brought forward		$827,283 78
Mechanical Department—		
Office supplies and equipment	$5,213 34	
Experimental laboratory	9,614 35	
Machine shop	8,733 39	
Foundry	1,329 45	
Forge shop	1,964 33	
Wood working machinery and tools	3,292 52	
Front office, Mechanical Building	156 00	
Miscellaneous	373 20	
		30,676 58
Department of Physics—		
Furniture and fixtures	$2,792 77	
Mechanics	599 05	
Sound	170 70	
Galvanometers	597 80	
Resistance boxes	1,696 20	
Balances	292 00	
Static electricity	996 00	
Magnetism	46 50	
Electrical engineering	9,180 48	
Heat	406 15	
Light	1,439 20	
		18,216 85
Women's Department—		
Reception room and hall	$652 75	
Dean's office	189 10	
Day students' room	255 00	
Parlor	639 50	
Guest room	62 75	
Dormitory furniture	1,689 35	
Miscellaneous	152 19	
Recitation room	6 85	
Store room	29 95	
Dark closet	60 28	
Music rooms	2,217 38	
House library	100 30	
Gymnasium	614 92	
Shower bath rooms	66 55	
Domestic art department	974 11	
Library	80 86	
Office	107 65	
Kitchen utensils	234 69	
Laundry	70 00	
Glassware	18 28	
China	55 14	
Crockery	17 24	
Miscellaneous	35 71	
Linen	41 26	
Dining room furniture	97 40	
		8,469 21
Department of Zoology and Geology—		
General museum	$17,993 00	
Furniture and apparatus	1,526 38	
Tools	28 63	
Dissecting instruments	65 97	
Drawing instruments and material	12 00	
Photographic supplies	327 60	
Microscopic	1,403 27	
Miscellaneous	823 50	
		22,180 35
Amount carried forward		$906,826 77

Amount brought forward	$906,826 77
Carpenter shop	719 48
Cleaning supplies	180 35
Drawing Department, furniture and equipment	4,505 70
English Department, furniture and equipment	646 14
Entomological Department, furniture, supplies, etc	3,747 14
Farmers' Institutes, furniture, etc	584 44
Fire Department, equipment	724 83
Forestry Department, furniture, tools, etc.	11,160 58
Furniture in Board Rooms	151 90
Furniture in Wells Hall	1,560 00
Furniture in Chapel	576 80
Furniture in Post office	269 50
Department of History and Economics	434 60
Hospital	228 90
Library	53,863 11
Military	1,231 30
Nursery and Orchard Inspection Department	87 46
Paint shop	371 60
Physical Culture and Athletics	723 62
President's Office	628 57
Secretary's Office	1,354 89
Veterinary Department, apparatus and equipment	2,274 11
Weather Service	1,500 12
Miscellaneous	751 00
Total	$995,102 91

SUMMARY OF EXPERIMENT STATION INVENTORY.

Lands donated to the Station—		
80 acres at Grayling, fenced and improved at cost	$1,000 00	
5 acres at South Haven, fenced and improved	1,000 00	
160 acres at Chatham, including buildings	4,000 00	
		$6,000 00
Buildings—		
Bacteriological stable	$3,700 00	
Experiment station feed barn	800 00	
Veterinary laboratory, experimental rooms	250 00	
House	1,000 00	
Station Terrace building	3,000 00	
Seed room	500 00	
Slaughter house	625 00	
Storage barn	600 00	
Insectry	1,000 00	
		11,475 00
Bacteriological department—		
Literature	$2,151 48	
Chemicals	274 24	
Apparatus	2,805 93	
		5,231 65
Chemical Department—		
Apparatus	$1,773 87	
Chemicals	245 88	
Porcelain ware	45 10	
Office furnishings	81 80	
Tools	4 95	
Platinum	686 30	
Filter paper	25 54	
Glassware	368 30	
		3,231 74
Entomological Department—		
Office	$1,807 80	
Books	530 20	
Apparatus	1,070 70	
Supplies	88 04	
Glassware	223 78	
Chemicals	104 70	
Spraying machinery	54 35	
Sundry	65 40	
		3,944 97
Farm Department—		
Farm tools and equipment	$909 98	
Apparatus—soil department	476 22	
Office	341 01	
Books	13 90	
Apparatus	326 10	
Glassware	22 23	
Sundry	5 48	
Dairy	1,323 55	
Dairy office	2 40	
		3,420 87
Horticultural Department		88 54
Library		4,415 50
Secretary's Office		253 93
South Haven Station, equipment		337 80
Upper Peninsula Station, equipment		1,224 16
Total		$39,624 16

REPORT OF THE PRESIDENT.

To the Honorable State Board of Agriculture:

Gentlemen: I take pleasure in presenting to you my report as President of the college under your charge for the year ending June 30, 1908.

The year just closed was one of substantial progress. A spirit of quiet, earnest effort pervaded the work of both faculty and students throughout the year. Nothing of an unusual character occurred to interfere with the orderly progress and harmonious feeling so necessay to the highest efficiency of classroom instruction.

The increase in attendance over the previous year was about twenty per cent. The enrollment for the year fell nine short of twelve hundred. The graduating class numbered eighty-four, distributed as follows: Engineering, forty-five; Agriculture, twenty-two; Forestry, three; Women's Course, fourteen. Five advanced degrees were also conferred as follows: to Louis C. Brooks, B. S., '92, the degree of Electrical Engineer; to William D. Hurd, B. S., '99, the degree of Master of Agriculture; to Frank F. Rogers, B. S., '83, the degree of Civil Engineer; to Alva T. Stevens, B. S., '93, the degree of Master of Science; to Dr. Edward A. A. Grange, the honorary degree of Master of Science.

The baccalaureate sermon was given this year by the Rev. Ernest B. Allen, D. D., pastor of the Washington Street Congregational Church, Toledo, Ohio. Miss Jane Addams, LL. D., of Hull House, Chicago, gave the Commencement address. The exercises were held at ten thirty in the Armory, June 23.

A very brief and somewhat extemporaneous meeting was held on the site of the new Agricultural building previous to the Commencement exercises at which the corner stone of the new building was laid. A sealed copper box containing a catalog of the college and a few other documents were placed in the stone which was officially laid by the Hon. A. J. Doherty, a member of the State Board.

On the day preceding Commencement the dedicatory exercises in connection with the new Engineering building were held. A platform was erected among the trees in front of the building. Music was furnished by Fischer's orchestra of Kalamazoo and the address was made by Rolla C. Carpenter, LL. D., Professor of experimental engineering, Cornell University. This address was of exceptional merit and can be found in the Commencement edition of the M. A. C. Record.

In recent years Commencement has been held on Wednesday; the annual society reunions and parties on Monday evening. This made it very inconvenient for the Alumni who were anxious to attend both. Mainly for their accommodation the faculty decided that in the future, Commencment would be held on Tuesday and the reunions and parties of the Literary Societies would be held on the evening of the same day. This

will also make it easier for students who so desire to attend the Commencement exercises.

The names and addresses of those receiving degrees are as Follows:

Students in Agriculture are designated by *a*; Engineering by *e*; Home Economics by *h*; Forestry by *f*.

Name.	Postoffice.	County.
Allen, Marshall R., *a*	Ithaca	Gratiot.
Andrews, Neina F., *h*	Williamston	Ingham.
Baker, Philip J., *e*	Holland Patent	New York.
Barden, Floyd M., *a*	South Haven	Van Buren.
Barley, Arthur T., *e*	Detroit	Wayne.
Barlow, Florence M., *h*	Greenville	Montcalm.
Beal, Fannie E., *h*	Addison	Lenawee.
Beard, Hazel A., *h*	Morrice	Shiawassee.
Born, Frank G., *e*	Dowagiac	Cass.
Boyle, Jesse, *a*	Buchanan	Berrien.
Brown, Walter P., *e*	Hartford	Van Buren.
Brewster, Archie W., *e*	Detroit	Wayne.
Burrell, Leroy L., *a*	South Haven	Van Buren.
Campbell, James R., *e*	St. Johns	Clinton.
Carr, Ralph J., *a*	Fowlerville	Livingston.
Carr, Roswell G., *a*	Fowlerville	Livingston.
Carrel, Ruth, *h*	Charlotte	Eaton.
Charlton, Irving D., *e*	Coats Grove	Barry.
Christensen, Leonard E	Columbus	Ohio.
Cobb, Myron H., *a*	Lansing	Ingham.
Conolly, Henry M., *a*	Hartford	Van Buren.
Covell, Bess, *h*	Whitehall	Muskegon.
Darbee, Acastus L., *a*	Caro	Tuscola.
Dice, James R., *a*	Enon Valley	Pennsylvania.
Dikeman, Myron J., *e*	Sunfield	Eaton.
Dodge, Glenn W., *e*	Almont	Lapeer.
Dwight, Albert C., *e*	Decatur	Van Buren.
Ferguson, Maud E., *h*	Haslett	Ingham.
Fuller, Lewis S., *e*	East Lansing	Ingham.
Gilbert, Roy H., *e*	Reed City	Osceola.
Gongwer, J. Verne, *e*	Hart	Oceana.
Hagaman, Harry W., *e*	Frontier	Hillsdale.
Hall, Marion E., *e*	Chesaning	Saginaw.
Heller, Charles S., *a*	Philadelphia	Pennsylvania.
Hill, Newell J., *e*	Vassar	Tuscola.
Hopson, Walter A., *f*	Detroit	Wayne.
Horton, Samuel W., *a*	Fruit Ridge	Lenawee.
Hurlburt, Amy D., *h*	Mason	Ingham.
Hyde, Lora M., *h*	Prairieville	Barry.
Inglis, Jean A., *h*	Detroit	Wayne.
Kiefer, Francis, *f*	Grosse Pointe Farms	Wayne.
Koehler, Irving G., *e*	Detroit	Wayne.
Krehl, Edward C., *a*	Buffalo	New York.
Lemmon, Kelley B., *e*	Lansing	Ingham.
McVannell, George H., *e*	Flint	Genesee.
Marsh, Herbert E., *e*	East Lansing	Ingham.
Martin, Evan S., *e*	East Lansing	Ingham.
Merwin, Clyde E., *e*	Moscow	Hillsdale.
Mosher, Mabel, *h*	Lansing	Ingham.
Musselman, Harry H., *e*	Cecil	Ohio.
Norton, Charles B., *e*	Howell	Livingston.
O'Gara, Francis, *e*	Ottawa	Ontario.
Owen, Grace, *w*	Vernon	Shiawassee.
Parker, Ward H., *a*	Lansing	Ingham.
Pearsall, Ropha V., *e*	Lansing	Ingham.
Pratt, Mary E., *h*	Middleville	Barry.
Race, Shelby E., *e*	Grand Rapids	Kent.
Rider, William M., *a*	Buffalo	New York.
Rigertink, Albert, *a*	Hamilton	Allegan.
Riley, Earl F., *e*	Mt. Pleasant	Isabella.
Rogers, B. Carl, *e*	East Lansing	Ingham.
Rork, Elmer J., *e*	Lansing	Ingham.
Rosen, Joseph A., *a*	Tula	Russia.
Rouse, Herbert M., *e*	Owosso	Shiawassee.
Shassberger, Ernest J., *e*	Grand Rapids	Kent.
Sherman, Harold C., *e*	Kalamazoo	Kalamazoo.
Shull, Huber, *a*	Kingston	New York.
Shroyer, Percy C., *e*	Bridgeman	Berrien.
Small, Ray A., *e*	Benzonia	Benzie.
Small, Walter H., *e*	Charlevoix	Charlevoix.

Name.	Postoffice.	County.
Snyder, Anthony LeMoyne, *e*	Florence	COLORAO.
Stephenson, Oic W., *c*	East Saginaw	Saginaw.
Sutherland, Clarence H., *e*	Detroit	Wayne.
Tenkonohy, Franklin V., *e*	Detroit	Wayne.
Valentine, Gilbert S., *e*	Jackson	Jackson.
Walkup, John M., *a*	East Lansing	Ingham.
Warner, Grace L., *h*	Doster	Barry.
Wilbur, John W., *a*	Troy	Oakland.
Wilcox, Arthur R., *f*	South Haven	Van Buren.
Wilcox, Eugene I., *a*	South Haven	Van Buren.
Williams, Claude V., *c*	W. Bay City	Bay.
Wilson, Frank B., *a*	Ypsilanti	Washtenaw.
Wood, Lloyd E., *e*	Belding	Ionia.
Zimmer, Walter E. A., *e*	Sebewaing	Huron.

Counties represented in entering class.

Antrim	3	Livingston	3
Allegan	5	Mackinac	4
Barry	5	Macomb	3
Bay	3	Manistee	3
Berrien	8	Marquette	2
Benzie	2	Leelanau	1
Branch	5	Mason	3
Calhoun	8	Mecosta	2
Cass	1	Menominee	1
Charlevoix	1	Midland	2
Cheboygan	3	Missaukee	3
Chippewa	4	Monroe	4
Clare	1	Montcalm	2
Clinton	11	Muskegon	5
Crawford	3	Newaygo	4
Delta	2	Ogemaw	2
Dickinson	2	Oakland	12
Eaton	7	Oceana	4
Emmet	1	Ontonagon	1
Genesee	5	Osceola	1
Grand Traverse	5	Otsego	1
Gratiot	5	Ottawa	4
Hillsdale	8	Sanilac	1
Huron	4	Saginaw	5
Ingham	67	Schoolcraft	1
Ionia	8	Shiawassee	9
Iosco	4	St. Clair	6
Jackson	11	St. Joseph	7
Kalkaska	1	Tuscola	1
Kalamazoo	8	Van Buren	7
Kent	31	Wayne	30
Lapeer	4	Washtenaw	7
Lenawee	12	Wexford	4
Houghton	6		

Other states and countries represented.

California	1	New York	8
Colorado	1	Ohio	8
Connecticut	1	Oregon	1
England	1	New Jersey	1
Illinois	6	Pennsylvania	3
Indiana	4	Vermont	1
Japan	5	Virginia	1
Kentucky	1	Washington	1
Mexico	1	West Virginia	2
Minnesota	1	Wisconsin	3

Summary of students.

	General Agric'l.	Cream-ery.	Fruit.	Cheese.	Engi-neering.	Agricultural.	Engineering.	Home econo-mics.	Forestry.	Totals.
Post Graduates						1	......	5	......	6
Class of '08						25	47	15	4	91
Class of '09						32	63	18	10	123
Class of '10						37	92	24	12	165
Class of '11						104	174	43	......	321
Sub-Freshmen						57	100	36	......	193
Special Students						20	9	58	......	87
Special Course Students	119	60	19	8	......	206	......	......	......	206
Totals						482	485	199	26	1,192
Deduct names repeated						......	......	......	......	1
Final total						......	......	......	......	1,191

CHANGES IN FACULTY.

During the first fifty years death did not enter the ranks of the active teaching force of the college. This statement is believed to be true although written without first making a thorough examination of the records. However, within a few months of the semi-centennial celebration two of the most valued and most active members of the faculty were removed by death.

Prof. Ernest Everett Bogue, died on August 19th, 1907, from the effects of an operation for appendicitis. Professor Bogue was born January 12th, 1864, at Orwell, Ohio. He was of French Huguenot stock on his father's side. His father was a well-to-do farmer. Mr. Bogue's mother was a woman of great strength, physically and mentally,—a great worker and a great reader.

His earliest ambition was to secure for himself a higher education, and the first money he earned was used to this end.

He took the three years' course at New Lyme Institute, Ohio, and from there went to Columbus to enter the Ohio State University in 1890. He worked his way through the four years' course and one year Post Graduate work, with almost no outside help and graduated in the course of Horticulture and Forestry in 1894. He did a good deal of special work in botany and entomology and in March, 1896, accepted a position of Botanist and Entomologist in the Oklahoma Agricultural College, taking with him his wife to whom he was married on March 25th, 1896. He remained in this position until the spring of 1900, when he left to spend a year at Harvard, receiving later the degree of A. M. from that institution.

When the Forestry Department was established by the State Board, Prof. Bogue was placed in charge, taking up his work at the opening of the college year, September, 1902. He organized the department and carried it on very successfully until his death.

Prof. Bogue was an earnest, conscientious, untiring worker. He spared no efforts to give to his students the latest and the best information in his field of effort. Professionally he was accorded high rank by all who knew him and many were the expressions of regret received from his friends throughout the country. He always had the esteem and affection of his students. He was a valuable citizen. At the time of his death he was a member of the City Council of East Lansing. He was also, and had been for several years, Superintendent of the local Sunday school. To him more perhaps than to any other person was due the credit for the success of this enterprise. He was a good man and his death was a great loss to the college and the community.

Prof. William S. Holdsworth, Professor of Drawing and Design, died of tuberculosis on September 18th, 1907.

Professor Holdsworth was born in London, England, February 28th, 1856. He was a graduate of this college with the class of 1878. After further study and practical work in Chicago he was called back in 1881 by his Alma Mater to teach drawing. He was promoted from

time to time until finally a department was established and he was placed at its head. His work was always of an exceptionally high order. He gave his best efforts and was satisfied with nothing less from his students. It is said by those capable of judging that he had unusual natural ability as an artist and that he would undoubtedly have won very favorable recognition had he given his life to landscape painting. Many of his sketches in water color made when off on brief excursion trips are valued highly by his friends and are said to have great merit. His life, however, was given to the instruction of college students. Several thousand came under his personal tuition and have felt more than they know or can express the unlift of his clean, uncompromising personality. He was the soul of honor. No one who knew him ever had any doubt as to his integrity or honesty of purpose. His life, his language and habits of thought were pure. He had a fine sense of humor and a strong affection for his friends. He was a high type of Christian manhood and bore his sufferings to the last with a heroism which challenged the admiration of all his friends.

Professor Clinton D. Smith, Director of the Experiment Station, Dean of Short Courses and Superintendent of college extension work, resigned April 30th, to accept the presidency of the Luiz de Queiroz College of Agriculture at Piracicaba, Brazil.

Professor Smith was elected Professor of Agriculture in September, 1893. In September, 1895, he was also made director of the Experiment Station. The work in both departments developed so rapidly under his care that it was found advisable to permit him to direct his energies along the lines of work indicated by his title as given above.

The development of our Agricultural Course as well as the rapid growth of our Experiment Station owes much to the energy and ability of Professor Smith. The short courses are almost entirely due to his untiring efforts. His public addresses and newspaper articles brought the college to the attention of the public and did much to gain for it the confidence of the farmers of the State. He is a man of broad scholarship, high ideals and clean life. He took a great interest in the welfare of the students and made many personal sacrifices in their behalf. Thousands have felt the inspiration of his personal touch and their earnest solicitations and best wishes for his continued success will follow him to his new field of labor. The home of Professor Smith, made even more cheerful by his thoughtful and devoted wife, will be greatly missed on the campus. The college and the State owe a debt of gratitude to this man.

Dr. Stephenson W. Fletcher, who had charge of the Department of Agriculture since 1905, resigned February 1st, 1908, to accept the directorship of the Virginia Experiment Station. Dr. Fletcher is a man of character and ability. His short period of service in this college was marked with the spirit of progress and his sudden withdrawal from our ranks is a matter of keen regret.

AGRICULTURAL DEPARTMENT.

The rapid development of the various lines of Agricultural instruction together with the fact that this work will soon be centralized in our new agricultural building made it seem advisable to the board to place the various lines of work, such as agriculture, horticulture, veterinary science and forestry under one person as dean. Prof. Robert S. Shaw who has been the efficient head of our Agricultural department for the past six years was appointed to this responsible position. He had scarcely taken charge when the resignation of Professor Smith as director of the Experiment Station made it necessary to add to his duties that of director. He will be ably assisted in the latter position by Dr. Chas. E. Marshall who will act in the capacity of Scientific and Vice Director. While subordinate to Professor Shaw as director he will be charged with the responsibility of directing the scientific work of the Station, especially the research work carried on by virtue of the Adams fund. During the past year there have been employed by the Experiment Station three well trained men who will devote their entire time to investigation work under the provisions of the Adams Act. One is assigned to each of the following departments, Chemistry, Bacteriology and Entomology.

FORESTRY.

Prof. J. Fred Baker was elected to the Professorship in Forestry made vacant by the death of Prof. Bogue. Prof. Baker graduated from this college with the class of 1902. Later he completed the forestry course in Yale University and was in the government service for some time. He was Professor of Forestry in Colorado College when called to his present position. He has entered upon his duties with great energy. The State Legislature at its last session set apart as a college forest reservation the forty-two thousand acres of land in Alcona and Iosco counties which was the portion remaining unsold of the land donated to the college by the National Government under the Morrill Act of 1862. No funds were provided by the State for replanting these lands or protecting them from fire.

In order that our forestry students might have some instruction under actual forest conditions it was planned to hold a summer session on this reservation for the students in our forestry course. The Attorney General, however, refused to permit the Board to use college funds for this purpose and the project had to be abandoned for the present. It is hoped that the summer school in forestry may be made possible for next year by inducing the next Legislature to amend our college bill. It is also very much desired that the Legislature will provide funds for the protection and improvement of the forest reservation. The college does not have sufficient income to undertake this great work, however desirable it may be. If this land which is known as jack pine plains—principally light sand—could be replanted or even protected from fire for a long series of years it would no doubt return a handsome income to the college. It should be done and the work should begin at the earliest possible date.

DRAWING AND DESIGN.

The Professorship in drawing and design made vacant by the death of Prof. Holdsworth, has recently been filled by the appointment of Prof. Victor T. Wilson, who was called from a similar position in the State College of Pennsylvania. Prof. Wilson is a graduate of Cornell University. He is a successful teacher and the author of valuable text books on Free Hand Perspective and Free Hand Lettering.

During the vacancy in this position the work of the department was ably directed by the first Assistant Professor, Chase Newman. Much credit is due him for the success of the department during the past year.

DEPARTMENT OF AGRICULTURAL EDUCATION.

In recent years there has been a growing demand for the introduction of agricultural instruction into the public schools. The great obstacle in the way has been the lack of qualified teachers. The college has been appealed to on all sides to assist in this movement. Many high schools are ready and anxious to introduce strong lines of work in agriculture but teachers capable of giving such instruction cannot be secured. The county normal training schools, of which there are thirty-eight in the State, are trying to give agricultural instruction to the young people who are preparing to teach rural schools. They need assistance in this noble undertaking.

The responsibility of leadership in this new and desirable field of work seemed to lie with the Agricultural College. It is the only institution in the State prepared to give instruction in agriculture. It cannot, of course, train teachers for rural or graded schools, but it can prepare teachers for the county normal training schools, the high schools and State normal schools. These in turn can train the teachers for rural and graded schools. In this way a large number of teachers within the next few years can be fairly well prepared to give instruction in elementary agriculture.

The College, ever ready to meet the responsibilities which come to it, has established a Department of Agricultural Education. Prof. Walter H. French, who has ably filled for a number of years the position of Deputy State Superintendent of Public Instruction has been placed in charge and will direct and develop this department. The inauguration of this new department has attracted attention throughout the country. In an able paper read by President Thwing before the National Education Association at Cleveland, mention was made of this department as one of the important progressive movements in education during the past year.

BUILDINGS.

The engineering departments during the past year have enjoyed very much their new quarters.

The new agricultural building is well under way but will not be ready for occupancy before the Fall of 1909. A full description of this building will be given after its completion. It may, however, be stated here that it is of fireproof construction and will be when completed the largest and best building on the campus.

LITERARY SOCIETIES AND SOCIETY HOUSES.

The rapid increase in attendance during recent years has had a tendency to change somewhat the social life of the student body. Formerly nearly all students lived in dormitories, took their meals in large boarding clubs and seventy-five per cent or more belonged to one of the Literary Societies which occupied rooms, fitted up by the members of the societies, in the basement or upper story of one of the dormitories. These societies in addition to literary work held parties and dances occasionally. Under these conditions student life was very democratic. Rich and poor were on the same level. Each student formed an intimate acquaintance with a large number of fellow students. If he completed a full course he could number his friends by the hundred, if not by the thousand. In after life he appreciates these friends. They seem to be the only true, and ever to be trusted friends that he has ever had. He values these friendships as one of the chief assets of his college life.

The addition of the women's department improved the social side of college life. The young men became neater in appearance and more refined in manners. The opportunity for enjoying the society of refined young women was greatly increased and greatly we believe to the advantage of the young men.

When the new Wells Hall was erected six suites of rooms were finished off on the top floor for the use of societies. Three fine suites of rooms are occupied by societies in Williams Hall. The rooms in the new dormitory are not to be used for parties at which young women are to be present. The armory is open for the use of societies for social functions.

One society erected some years ago on the campus a building exclusively for its own use. It does not provide living rooms for its members. It is open at all times and serves as a social center for its members. They can gather in its parlors after supper, hold their literary and business meetings on Saturday evening and when desired hold their dances or other social meetings in its spacious rooms. As this building is on the campus it pays no taxes and receives its heat and light from the college at cost, hence the expenses for maintenance are very low. This building has proved very satisfactory to all concerned.

One society has erected a building off the grounds. This is built on the plan of the modern fraternity house and provides boarding facilities and living rooms for the majority of its members. It has been in operation too short a time to draw safe conclusions from its experience.

Two other societies live in rented buildings off the campus. They pay high rent and have no boarding accommodations and very cramped room for literary or social purposes.

There seems to be a very marked and strong tendency on the part of several of the older societies to erect their own buildings which will provide living rooms and boarding facilities for their members; in other words to follow the fraternity house plan as may be seen in most of the large universities which are not provided with dormitories.

It seems evident that the college is now at the parting of the ways

as to the social life of the student body. If a number of fraternity houses are erected off the campus they must of necessity, on account of the increase in expenses, draw to them the students who have money. The students of limited means will live in the dormitories, but the fraternity houses will set the social standard and as is the case in our universities, the fellow not connected with a fraternity house will have practically no standing socially. If this time should come the democratic spirit of the campus—that social equality which has been the salvation of the poor boy—will be a thing of the past. There is much in the college fraternity and fraternity house to be commended, and also much that is far from commendation, but the question is not as to the principle of their organizations and the mode of student life which they foster, but rather as to the advisability of changing from the free, democratic, wholesome social life which has characterized this college in the past to the exclusive, expensive and somewhat aristocratic idea as indicated by the modern trend of fraternity life in our larger institutions. The reputation of this college has been made by alumni who almost without an exception were students of little means. The student body of the present day belongs mainly to the same class. Their means are limited. They can no doubt afford more luxuries than could the students of thirty years ago, yet their funds come largely from the careful savings and sacrifice of their parents. Should not the authorities of the college and the alumni adopt every means possible to furnish to these young people the very best opportunities both educational and social at the minimum cost?

SUGGESTIONS.

The college should at the earliest possible date consistent with the other needs of the institution erect more domitories for young men. These, of course, should provide large well lighted and well ventilated living rooms with all modern sanitary accessories. Some of the advantages in favor of the dormitories are that they furnish good sanitary rooms at small cost. Thirty dollars per year will provide good living quarters for a student including heat and light. Dormitory life gives the student good training. He learns to live with others, to have a proper regard for their rights and to conform to the general customs which prevail in community life. The money spent by the college for the erection of a dormitory in a sense is an investment as it will return in rents even at moderate rates from three to four per cent net on the outlay. The trend among our large institutions in recent years is toward dormitory life. Harvard has sixteen dormitories. Princeton has erected several within the past few years and Cornell will do so as soon as funds are available.

The college should also build a large centrally located dining hall. This should be fitted up with all modern conveniences and appliances and sufficiently large to accommodate ten or twelve hundred students if necessary. This would make it possible to furnish good, wholesome board at the minimum cost. It would also foster that democratic spirit which is desirable especially in institutions supported by taxation.

A new gymnasium is very much desired and should be provided

soon. This building should provide large parlors and sufficient space for dancing to make it possible for several parties to be held on the same evening. This building might also provide rooms for general headquarters for the student body and especially for those not affiliated with one of the societies.

Societies and alumni should be encouraged, without incurring large indebtedness, to erect society buildings for literary and social purposes. These buildings should contain a few fine rooms for the exclusive use of the alumni, as well as room for two students who would have direct charge of the building. An alumnus should feel free to drop in and occupy a room at his convenience and should not feel that he was inconveniencing any one in so doing. These buildings should be fine specimens of architectural design and should contain parlors, lounging rooms, reading room and as large a room as possible for general meetings, receptions, etc. In my opinion these buildings should be on the campus. They should be so near to the dormitories and dining rooms that students could drop in during vacant hours or after meals and thus use them as social centers. They also should be on the campus for economic reasons. If the State Board was willing the site for such buildings would cost nothing, the heat and light would be secured at cost and no taxes would be levied. This would make the expense for maintenance comparatively small—so small as to be within the reach of any student. The average M. A. C. student cannot afford to live in the modern fraternity house, and as these societies have been developed and maintained by the students of moderate means their traditions can best be conserved and perpetuated by students of the same class and not by students who will of necessity be selected because of their ability to meet large expense accounts. As the college grows there will come to it a class of students who will desire and can afford something better than that enjoyed by the average student. This class can be taken care of in the new dormitories or private families. They will be few in number in this college for many years to come and there need be no fear as to their securing comfortable quarters. One thing certain the student with money should not be permitted to set the social standard as he has done in so many of our larger institutions.

If the suggestions as outlined above can be adopted and followed the democratic traditions of the college can be maintained. Social centers will develop on the campus and will be open to the vast majority of students. These social centers or societies will be so varied in character as to meet the tastes of the different classes of students. This is true of the societies at present and no doubt will become even more pronounced in the future. Methods of living for students will develop and improve in convenience, cleanliness and sanitation in keeping with the rapid progress along these lines in home and community life. Very good accommodations in the way of rooms, board and social privileges can thus be provided for students at a cost within the reach of the average boy. It should not be forgotten that this institution is maintained for the average young man. His interests are paramount. This institution should not be permitted to grow away from him as has been the experience of so many of the great institutions of this country.

These suggestions are commended to the careful consideration of the

State Board as well as to the thoughtful consideration of the Alumni whose wise council and cooperation are always gratefully appreciated.

East Lansing, June 30, 1908.

J. L. SNYDER,
President.

REPORT OF THE DEPARTMENT OF PRACTICAL AGRICULTURE.

To President J. L. Snyder:

The following is a report of the Agricultural Department for the year ending June 30th, 1908.

As those in charge of the various divisions of the department have kindly furnished brief statements relative to their lines of work my report will be confined largely to animal husbandry and general farm matters. During this year the personnel of the department staff underwent comparatively few changes, there being but three. At the beginning of the year, Mr. F. W. Howe was made instructor in farm crops, W. B. Liverance instructor in dairying, and the foremanship of the farm was placed in charge of R. S. Hudson, January 1st, 1908.

The head of the department was assisted in animal husbandry during the year by Instructors H. W. Norton and A. C. Anderson, with the division of duties and responsibilities much the same as last year. G. A. Brown rendered valuable service by aiding in carrying on the beef cattle and sheep experiments and assisting to some extent with the instruction work. The following instruction work was given in the division, viz.: for sub-freshmen, live stock, fall term, 55 men, 6 hours per week, 12 weeks; freshmen, stock judging, fall term, 67 men, 5 hours per week, 12 weeks; sophomores, stock judging, fall term, 33 men, 5 hours per week, 12 weeks; juniors, stock feeding, winter term, 29 men, 3 hours per week, 12 weeks; seniors, advanced stock judging, fall term, 25 men, 10 hours per week, 10 weeks; meat cutting for seniors, winter term, 12 men, 10 hours per week, 12 weeks. In the special short courses 89 first year students received instruction in live stock, 9 hours per week, for eight weeks, and 27 second year men advanced stock judging 10 hours per week during the same time.

During the previous year an extensive live stock educational exhibit was shown at several of the leading fairs of the state. The exhibit comprised eighteen head of cattle and thirty-two head of swine. The animals were used to illustrate various methods of economic feeding for meat production. This year another exhibit, consisting of fifteen cattle and twenty sheep was displayed at fairs at the following places, viz.: Detroit, Grand Rapids, Reed City, Greenville, Benton Harbor and Hillsdale. The animals used in this exhibit demonstrated possibilities for improving live stock though certain simple, practical methods of breeding, in which good sires are used. One part of the display, comprising seven animals, consisted of three scrub cows, a Hereford bull, and their progeny, three grade calves which showed marked Hereford type, and wonderful improvement in quality over the female ancestors.

The other group consisted of four high grade Shorthorn cows, two of them with progeny sired by the Hereford bull, the other two by a scrub bull. One of the scrub calves had been pail fed and the other had suckled the dams; the same was true of the two grades. These groups made an impressive illustration of the possibilities of improving scrub or grade cattle by using pedigreed sires and emphasized the fallacy of the use of scrubs.

Two pens of common, mixed bred western sheep of five each were shown in pens side by side with their lambs, one pen of which was sired by an imported Hampshire ram, the other by a scrub.

Those who accompanied these exhibits did more or less judging at the smaller fairs in addition to a number of other places. In such cases the services of the men are given without charge except such as to cover the actual expenses.

Herds and Flocks. A vigorous effort has been put forth during the past few years to develop good, strong, representative herds and flocks in all the lines of animal industry in which Michigan is especially interested. The following are the present members of our herds and flocks, viz.: Horses, 18 head; pure bred beef cattle, 41; grade beef cattle, 37; pure bred dairy cattle, 50; grade dairy cattle, 40; registered sheep, 174; grade sheep, 159; registered hogs, 147; grade hogs, 23.

The cattle, sheep, swine and poultry divisions have been placed on fairly satisfactory footings and an effort is being made to improve the horses. During the year six registered mares were procured, viz.: Four Percherons in Iowa and a pair of two-year-old, imported Clydesdale fillies in Canada. Two of the Percherons produced mare colts during the past spring. The plan is to replace most of the common farm work horses with pedigreed mares, to be used for both work and breeding.

The farm building equipment work is now practically complete and a full description of the regrouping, remodeling, and refitting of the various buildings has been given in Station Bulletin No. 250, with the exception of a manure shed erected since this report was issued. This manure shed, 30x60, was placed in the center of a court formed by the horse barn, beef cattle, bull and sheep barns. It is so arranged that the manure which is conveyed from the barn by means of carriers and overhead tracks can be dumped either on the manure spreader, which is under cover, or in the storage bins beyond. This system is needed especially to protect the manure spreaders, store manure at such times when it cannot go directly on the land and permit keeping the yards in a cleanly condition.

As Secretary of the Michigan Improved Live Stock Breeders' and Feeders' Association, Mr. Anderson, during the past year prepared a Live Stock Directory of the state, which at present contains the names, postoffice addresses, and classes of stock reared by over two thousand farmers, stock men and feeders of Michigan. This more complete directory will be of great assistance in extending the already quite wide and valuable influence of the Breeders' Association, in promoting live stock improvement, and in guarding Michigan live stock interests both within and without the State.

During the past year the secretary has acted as an agent or medium of exchange between buyer and seller, and by this means has helped to place much of the surplus pure bred stock where it is much needed.

General farm improvements comprise some additions to the drainage system, replacing fences and grading and filling low, wet, unsightly spots in 4, 14 and 18.

During the year the cleared portions of No. 18 has been drained and largely cleared of stumps.

The department has continued to do a large amount of investigation work along live stock lines, a report of which has been made to the Director.

Respectfully submitted,
ROBERT S. SHAW,
Dean.

East Lansing, June 30, 1908.

Professor Jeffery reports the following from the Agronomy Division:

Near the close of the college year, 1906-7, Mr. L. B. McWethy, assistant in agronomy, accepted a position with the Wyoming Agricultural College, and Mr. F. W. Howe accepted the position thus left vacant in this division. During the year Mr. Howe has had charge of the crop work designated as Ag 12a, and Ag 12b. The soil work designated as Ag 6, the short course classes in Parliamentary law and bookkeeping, respectively, and has assisted as occasion required in other instructional work. He had charge quite largely of the educational exhibits made by this division at the State Fair, and the West Michigan State Fair, has done some judging at county fairs, and spent nine days with the special institute train and some time in other college extension work.

During the year this division has given instruction to 226 regular students, in eight different subjects, and to 307 short course students in four different subjects. Nearly forty days have been given to extension and educational work away from the college.

Two laboratory courses in elementary agriculture have been prepared at the request of the Department of Public Instruction, and through that department given to the teachers of Michigan free, for their use in promoting the teaching of agriculture in the public schools of the State.

In two of the counties of the State, Muskegon and Mason, Boys' Corn Growing Associations have been formed. This movement is receiving the help of this division in the way of advice, personal instruction, bulletins, etc. Corn growing contests are now in progress and later corn shows and prizes are planned for.

Instructor W. B. Liverance reports the following from the Dairy Division:

Instruction has been given to 130 students, as follows: Fall term, Advanced Dairying, 14; winter term, special courses, Creamery Management, 62; Cheesemaking, 8; Farm Dairying, 15; spring term, Advanced Dairying, 4; Elementary Dairying, 34; instruction in the Babcock test was also given to about 60 special course general agriculture students.

Upon recommendation of the former instructor, Mr. F. O. Foster,

household dairying 11e, was stricken from the women's course of study, the course in elementary dairying was also shortened to six weeks. This, we feel, is a serious mistake, as six weeks does not allow enough time to cover the subject well and we would recommend that the course be changed to cover a period of twelve weeks as formerly. This year, however, circumstances were such that the subject was carried a full term.

Dairying 11c, for seniors electing advanced work was given over temporarily to the Department of Chemistry. This was done because of lack of equipment and working room in the dairy building, and also because of the inability of the instructor to devote the necessary time to the course because of the special course creamery and cheese work.

As heretofore the free testing of whole milk and cream samples has been continued. Time has also been taken to investigate and answer promptly all inquiries that residents of the state sent in.

The milk used to supply the boarding clubs during the college year has been handled at the dairy during vacation times. A total of 59,630 lbs. of milk has been secured in this way.

Besides the club milk, 123.3% lbs. of whole milk and 3.630 lbs. of cream have been secured from outside sources, which with the product from the college herd has furnished the material for laboratory work during the school year.

Plans are well under way at present for the operation of a model creamery at the Michigan State Fair this coming fall. Many of the leading creamery supply houses have very kindly offered us loans of dairy machinery and space in the dairy building at the fair grounds has been arranged for.

Instructor J. G. Halpin reports the following from the Poultry Division:

The following building has been done during the past year: Three colony laying houses 14x24 feet, with a capacity of 75 birds each; one long laying house 18x178 feet, capacity 800 laying hens, and 10 portable colony brooder houses 7½x12 feet. Suitable yards have been provided for the birds kept in these buildings, and in doing this, 148 rods of poultry fence has been put up. One hundred and fifty fruit trees have been planted in the different yards in order to furnish shade for the fowls and to get double use of the land.

A feed house 20x36 feet is in process of construction, and when completed will furnish an incubator room and killing room in the basement, feed bins for different feeds on the first floor, and a storage room on the second floor.

In order to fill the new house and replace some of the older birds about 1800 young chicks are being grown. These consist of Barred Rocks, White Wyandottes, Light Brahams, White and Brown Leghorns, and a few Rhode Island Reds and Buff Cochins. About 35 Pekin and Indian Runner ducks are also being raised.

The instruction given during the year is as follows: Fall term 9 men enrolled for Poultry, 5 b; winter term, 9 men enrolled for Poultry, 5 c;

and 15 special course men enrolled; spring term, 8 men enrolled for Poultry, 5 d.

An attempt to make the instruction as practical as possible was made and the students did considerable practical work on the plant.

In addition to the instruction given at the college, some judging was done at the fall fairs and winter shows, a number of farmers' institutes were attended and a trip was made on the institute train.

Instructor L. J. Smith reports the following from the Farm Mechanics Division:

The enrollment of students in the various classes in Farm Mechanics during the past college year is as follows: Regular course: Wood Shop, 60; Forge Shop, 73; Farm and Power Machinery and Concrete, 28; total, 161. Special Courses: General Agriculture. Wood Shop, 87; Forge Shop, 87; Farm Machinery, 25; Creamery Course, Creamery Mechanics, 62; total, 261. The total number of students who took work in this division was 335.

The division undertook the teaching of the Creamery Course men in Creamery Mechanics for the first time this year. This subject had previously been taught by men who were not on the regular teaching staff. This extra work necessitated the employment of a carpenter to give the instruction in the wood shop.

The equipment of the forge shop has been increased to accommodate 30 students at one time.

The increasing utility of concrete on the farm has warranted special attention being given this subject. Through the courtesy of several concrete machinery firms, we have been enabled to give the students some very practical work in making building blocks, silo blocks and concrete tile. In localities where good gravel is easily obtainable, concrete tile is taking the place of the glazed tile. The students also did some practical work in laying concrete walk.

Respectfully submitted,

ROBERT S. SHAW,

Dean of Agriculture.

East Lansing, June 30, 1908.

REPORT OF THE DEPARTMENT OF HORTICULTURE AND LANDSCAPE GARDENING.

President J. L. Snyder:

I submit the following report of the Department of Horticulture and Landscape Gardening for the year ending June 30, 1908.

The instruction given in the department during the past year has been as follows:

Fall term: Amateur Fruit Growing, Sophomores, 50; Commercial Fruit Growing, Juniors (Special Hort.), 7; Plant Breeding and Pomology or Landscape Gardening, Seniors, 9.

Winter Term: Plant Propagation, Sub-freshmen, 50; Floriculture, Juniors, 7; Literature of Horticulture and Pomology or Landscape Gardening, Seniors, 8.

In addition to this instruction, we also had a class of 19 special students in fruit growing, who were attending the special fruit growing course. And also 45 students from the general short course.

Spring Term: Amateur Gardening, Freshmen Agriculture, 93; Sophomore Women, 53; Landscape Gardening, Juniors, 8; Experimental Thesis work and Pomology or Landscape Gardening, Seniors, 8.

It will be noted from the above that the department is giving for the first time an opportunity for Seniors in horticulture to specialize in Landscape Gardening. Although fruit growing is the leading horticultural industry of the state, and we believe should be maintained as the dominant subject in the department, the demand by students for landscape gardening and by the public for men trained in this line, makes it of the utmost importance for us to meet this demand by training students in landscape gardening. It has been necessary, therefore, in the past year to purchase a small amount of apparatus for instruction in this subject. For the coming year, that we may handle this course properly, it will be necessary to equip one of the rooms in the department building especially for the teaching of landscape gardening.

During the past year, the department has also taken an active interest in several lines of extension work. By lectures and educational exhibits in horticulture at State Fairs, County Fairs, and meetings of the State Horticulture Society, the department has done much toward reaching and aiding the practical farmer and fruit grower in the many problems which confront him. We hope to continue and enlarge upon this phase of our educational work as far as our time and facilities will allow, as we believe this method of education to be not only the most direct in disseminating agricultural knowledge, but one of the best ways of gaining and maintaining that cooperative spirit which should exist between the fruit growers of the state and this department.

GROUNDS.

During the winter, the middle block of apple trees was thinned as suggested in the last report. In general, it may be said, that it has been our aim to continue the work of the department upon the plans laid out by Prof. Fletcher. It was deemed advisable, however, to defer the planting of a commercial pear orchard and a vineyard, since they would form such permanent plantings, until a successor to Prof. Fletcher had been appointed. Otherwise, the work of the department grounds has been carried on upon the same general lines as given in the last report.

One of the ever present and perplexing problems of the department consists in the maintaining and improvement of the college campus. Each year the rapid growth that is taking place in the college, necessitates an increased area of lawn, walks and roads to be constructed and cared for. Each year finds a new building, necessitating more grading and planting. All this we endeavor to accomplish out of an appropriation entirely inadequate for the purpose. The result is that our lawns being left, year after year, without receiving any fertilizer or manure, owing to the lack of funds to purchase and apply the same, are rapidly becoming depleted. Our new buildings are graded and planted in a

manner only commensurate with our funds. We hope, therefore, that you will see fit to increase our appropriation for the maintaining of the college campus in a manner according with its growth, and that always in the future a special appropriation be issued for grading and planting around these new buildings.

I wish to call your attention, also, to the college pond, just west of the horticultural building. This pond being without any regular source of supply and having no outlet except a small 4 inch pipe placed at a point so high that the water seldom reaches it, becomes in summer, nothing but a black, unhealthy pool of dirty water covered with green algae, which forms under such conditions, making the pond not only a blotch on the landscape of the college campus, but also a breeding place for mosquitoes and many unhealthful germs. The prominence of its location, and the conditions referred to, make it a matter of immediate concern.

ORGANIZATION.

The students of the department have felt keenly the resignation of Prof. S. W. Fletcher, which took place in the middle of the college year, his excellent work here having qualified him for the position of Director of the Experiment Station of Virginia. Being temporarily in charge of the department since that time, I wish to express my thanks and recognition for the earnest cooperative spirit in which both the students and instructors have united in making the work of the department most aggressive and instructive to the students and a pleasure to those in charge.

During the spring term we found it necessary to engage the services of Mr. Jesse Boyle, a senior of the class of 1908, as instructor to women students in amateur gardening. His services were most efficient and very satisfactory.

Respectfully submitted,
C. P. HALLIGAN,
Assistant Professor in Horticulture
and Landscape Gardening.

East Lansing, Mich., June 30, 1908.

REPORT OF THE DEPARTMENT OF BOTANY.

President J. L. Snyder:

With kind regards, accept my report for the year ending June 30, 1908:

A summary of the classes instructed.

Class.	Subject.	Term.	Hours per week.	Students enrolled.
Srs. and Jrs. in Agric. and forestry	Plant physiology	Spring	8	8
Senior women	Plant physiology	Fall	7	16
Seniors	Gen. morph	Winter	10	4
Srs. and Jrs. men and women	Plant path	Fall	9	8
Juniors	Grasses	Spring	10	2
Srs. and Jrs. agricultural	Weeds	Fall	4	6
Seniors, forestry	Trees and shrubs	Spring	5	2
Juniors, forestry	Trees and shrubs	Spring	5	7
Juniors, forestry	Histology woods	Winter	10	8
Sophomores, agricultural	Plant histology	Winter	7	55
Sophomores, agr. and for	Trees and shrubs	Spring	5	51
Sophomores, agr. and for	Ecology	Spring	3	43
Sophomores, women	Trees and shrubs	Spring	2	34
Sophomores, women	Plant histology	Spring	6	31
Freshmen, agr. and for	Taxonomy	Spring	10	79
Freshmen, women	Taxonomy	Spring	4	37
Freshmen, agr. and for	Beginning	Fall	3	14
Freshmen, agr. and for	Fruits and seeds	Winter	6	83
Freshmen, women	Fruits and seeds	Winter	6	41
Freshmen, agr. and for	Beginning	Fall	4	51
Freshmen, women	Beginning	Fall	4	26
Total class roll for the year				606

BOTANIC GARDEN.

Some of my recent reports give many details concerning freshets that damaged or killed some of the plants, and the continued efforts each fall to raise the earth up to or above high-water mark. Most of the soil for raising the garden was moved by team and scraper from the adjoining river bottom, leaving a tremendous cavity which was soon nearly filled by brush and other rubbish in variety. For additions to top soil much of the material came from the side of the bank below the garden, consisting of sand, top-soil and muck. For a long time past, the slow brook which flows through the midst of the garden was passed over in five convenient places by small rustic foot-bridges. After raising the earth from two to five feet or more the lower portion of the brook was at the bottom of a trench which spanned eighteen feet from bank to bank. These steep slopes were difficult to keep tidy, and were too steep to be easily cultivated. The State Board of Agriculture cheerfully granted means to construct a small cement tunnel over 250 feet in length to take the place of the lower portion of the open brook. The cavity over the tunnel was filled, or is to be filled, and thus we add to space available, and get the plants above high-water mark. The upper portion of the brook, about two-fifths of the

whole where the banks are low are still covered by a nice variety of wild native plants so pleasing to most people.

To secure dirt to raise the upper portion of the garden, the high bank on the south side occupied by honeysuckles, was lowered to high-water mark. To get into the garden with a loaded wagon this fall an unsightly roadway is left beside the brook. Later in the season, I hope to give this portion a good lift, possibly all that may need raising.

THE HERBARIUM.

Here are named the additions made during the current year:

Seed Plants, Ferns and their allies.

Home collections	70
S. M. Tracy, Biloxi, Miss, Specimens Cassava	3
C. F. Baker, Economic plants from Cuba	34
By exchange from Europe	237
W. W. Eggleston	66
M. L. Fernald, Plants from Quebec	122

FUNGI.

E. Bartholomew, Fungi Columbiana, Centuria XV and XVI	200

ALGAE.

F. S. Collins, Fascicles Fascicle XXIX	50
Total additions for the year	782

GENERAL SUMMARY OF PLANTS IN THE HERBARIUM.

Seed Plants, Ferns and their allies	81,227
Mosses and Liverworts	2,010
Lichens	1,186
Fungi	17,353
Algae	2,270
Grand total in Herbarium	104,046

THE ARBORETUM.

This piece of land of about an acre and a quarter is just south-east of the delta where two roads meet, one from Lansing, one from North Lansing. Planting of seeds was begun in the summer of 1875, thirty-three years ago, and twice after enlarged to the east and to the south. In 1882, there were growing about 152 species of woody plants that were planted in rows four feet apart. In some cases the species were parts of several rows blocked in together. The soil is nothing extra, mostly sand or sandy loam. About twelve years ago, the south-west corner was fenced off with other land and used for a deer park. It is needless to say the deer soon killed all shrubbery and the bucks killed many of the young trees by rubbing with their horns.

For eight or ten years students and others have kept a path open

extending diagonally across the lot in a northeast and southeast direction, doing considerable damage to trees near the path. It is kept well littered with newspapers and other unsightly rubbish. Not satisfied to keep a path of reasonable width, it has grown wider and wider, in places sixteen feet, on the margins of which small trees are cut and broken.

At the time the planting was begun there were no patterns to follow; hence, many mistakes were made, such as placing blackwalnuts on the highest sandy land and chestnuts on damp soil. The late Prof. Bogue believed the failures to plant properly were as instructive as correct planting. I mention at random a few of the things that impress me as interesting. A striped maple about five inches in diameter and eighteen feet high, now thrifty, in fruit, unique and uncommon; a dozen seedlings of the old French pear trees such as are found in Monroe, two of which have fruited; two rows of swamp white oak, the largest of which has a trunk barely four inches in diameter; sugar maples, most of which are much smaller than the largest which is five inches through a foot from the ground; the rows of European larch which were healthy and grew rapidly for fifteen years, when they began to decay and tip over; two canoe birches eight inches through, which have been peeled and otherwise disfigured; butternuts thirteen inches in diameter; white oaks seven to eleven inches; white ash seven to eleven inches; basswoods ten to eighteen inches; common locusts eighteen to twenty inches; chestnuts fifteen to eighteen inches; beeches ten inches; white oaks eight inches.

There are white pines perfect in shape, straight, thrifty, tall, sometimes with growth of three feet in a year. Last year some saw-flies devoured most of the leaves on the remaining trees of European larch. The locusts show scarcely a trace of any borers anywhere, although their sprouts have come up some rods from the first planting.

MORE ROOM FOR CLASSES IMPERATIVELY NEEDED.

This topic is mentioned as a matter of reference, not to inform you, Mr. President, for you have been familiar with the facts for ten years past.

The present building for Botany was never large enough. Three of the class rooms were planned for certain special and small classes in using compound microscopes and they are too small and inconvenient for other classes, that we are now obliged to meet in them. It is of first importance that we have rooms for classes in plant physiology which the professors of agriculture and horticulture and forestry have urged for four years or more.

All the botany taught is expressly planned to aid agriculture, horticulture and forestry. For six years or more I have had to refuse students admission to our small class in physiology for lack of room and convenience to accommodate them, a thing that no other department of this college has been obliged to do.

No horticulturist without a thorough knowledge of the principles of several departments of botany is capable of planning and conducting and interpreting experiments.

Morton's *Cyclopedia of Agriculture* contains these words: "To no

science is the agriculture of this country so deeply indebted as to botany."

Dr. Lindly of England said: "Good agriculture and horticulture are founded upon the laws of vegetable physiology."

Ex-President T. C. Abbot made the statement: "Agriculture, horticulture, forestry are applied botany, and botany is the only secure basis of agriculture."

STATE FAIR.

Last year, 1907, I made two trips to the State fair grounds for the purpose of installing about forty plants of economic interest, such as Bermuda grass, wild oats, wild wheat, three kinds of wild potatoes, several new weeds, etc. I have made one trip this spring, 1908, and have increased the plants to fifty.

DONATIONS TO THE DEPARTMENT.

From C. C. McDermid, Battle Creek, plant of Asclepias tuberosa, bearing light-colored flowers.

From A. G. Palcio of Durango, Mexico, specimens of native corn.

From Samuel Alexander, Ann Arbor, ten living plants of wild sunflowers, and asters.

From S. M. Tracy, Biloxi, Miss., plants of Cassava.

In justice, perhaps, in this list should be enumerated the names of persons giving large numbers of separates, bulletins (bushels of them), and books for review or for use of students, but they have been omitted, partially at least, for the reason that they were all acknowledged by postal cards or letter.

GIFTS TO OTHERS.

To Director Woods, Maine, two species of Solanum.

To S. B. Green, Minn., two species of Solanum.

To Director E. Davenport, Illinois, two species of Solanum; roots and seeds of two lots of orchard grass, and a large fescue.

To Director Jenkins, Connecticut, two species of Solanum.

To Director Brook, Amherst, Mass., two species of Solanum.

The species of Solanum referred to were Solanum tuberosum, native of Mexico, and Solanum Jamesii, native of Arizona.

Respectfully submitted,

W. J. BEAL,
Professor of Botany.

East Lansing, Mich., June 30, 1908.

REPORT OF THE DEPARTMENT OF BACTERIOLOGY AND HYGIENE.

President J. L. Snyder:

Dear Sir:—The class work of this department has gone on in much the same manner as in years past. Two subjects were omitted because of the changes taking place in the Agricultural and Women's courses.

We are unfortunate this year in losing Prof. W. G. Sackett, who has gone to take charge of the Bacteriological work in the Agricultural Experiment Station at Fort Collins, Colo. Dr. Wetmore leaves, also, on account of her health. Dr. Otto Rahn is taking Mr. Sackett's work and conducts it very acceptably.

I desire to speak of the hospital conditions existing at the college. Miss Ketchum has done excellent work in caring for the ailing who apply to her and in managing the hospital. From our experience for the past year or two, we are convinced that more extensive hospital facilities will have to be provided, if we are to take care of the sick students. It is true that the hospital is large enough when all are well; but when an epidemic appears, each year, we are becoming more helpless to handle it. If this situation continues very much longer, we shall be brought face to face with a disagreeable situation, and we shall not be able to hold epidemics in check. I have experienced periods when we have had as many as four communicable diseases existing here at one time. Under some such circumstances, it becomes exceedingly difficult to harbor and care for the sick, and also hold the communicable diseases in check. No one doubts the value of caring for the sick students properly, and also fighting epidemics appearing amongst the student body. It seems expedient, therefore, that some steps be taken in the near future to improve the hospital facilities. Accordingly, I recommend that this matter receive serious attention, and that something be done as early as possible. It is my belief that the cottage system for this place will be the least expensive and the most feasible and the most effective. These cottages could be located near the present hospital.

Very respectfully submitted,
CHARLES E. MARSHALL,
Professor of Bacteriology and Hygiene.

East Lansing, June 30, 1908.

REPORT OF THE DEPARTMENT OF FORESTRY.

To President J. L. Snyder:

The work of the Forestry Department from October 1, 1907, to June 30, 1908, may be reviewed as follows:

COURSE OF STUDY.

The course of study as set forth in the 1906-1907 catalog has been followed during the school year. The number of students enrolled each term by classes is as follows:

Term.	Sophomores.	Juniors.	Seniors.
Fall		9	4
Winter	49	9	3
Spring	25	8	3

The new course of study adopted by the faculty will be taken up next September. The provision made in the new course for a six weeks summer term on the Iosco County College Forest will facilitate the educational work of the department, as in no other way under existing conditions could this much needed professional work be added to the course.

The new course beginning with the Sophomore year is as follows:

SPRING TERM.

	Rec.	Lab. Hrs.
Forestry 1. (Elements of Forestry)	36	48

JUNIOR YEAR.

	Rec.	Lab. Hrs.
Summer Term:		
Forestry 3. (Forest Mensuration)		90
Fall Term:		
Forestry 4. (Forest Dendrology)		60
Forestry 5. (Forest Field Methods)		60
Winter Term:		
Forestry 6. (Forest History)		60
Forestry 4a. (Dendrology)		60
Spring Term:		
Forestry 7. (Silviculture)		72
Forestry 8. (Forest Physiography)		48

SENIOR YEAR.

	Rec.	Lab. Hrs.
Summer Term:		
Forestry 9. (Forest Management)		90

	Rec.	
Fall Term:		
Forestry 10. (Forest Law)	24	
Forestry 11. (Forest Technology)		120
Forestry 12. (Lumbering)	36	
Winter Term:		
Forestry 11a. (Forest Technology)		120
Forestry 9a. (Forest Management)	36	
Forestry 13. (Forest Protection)	24	
Summer Term:		
Forestry 14. (Forest Investigation)		120
Forestry 15. (Forest Policy)	24	
Forestry 16. (Wood Preservation)	36	

FOREST NURSERY.

The dual purpose of the Forest Nursery is to supply demonstration work for students and to produce sufficient tree stock to meet the demand of the farmers in the State woodlot work. This tree stock is also used in replanting open places in the college farm woodlots. These college farm woodlots are a great help in practical demonstration work.

There is now on hand in the nursery the following stock:

Coniferous, 4,635,464; Broadleaf, 1,228,924.

FOREST EXTENSION WORK.

Under a ruling of the State Board the department renders free assistance to farmers and land owners in making examinations and recommendations for the proper management of forest lands.

To date 113 applications have been received and filed; twenty of which have been visited and recommendations made. Gratuitous distribution of 3,377 forest trees was made to public institutions; 51,861 were sold to applicants at cost; 26,736 were planted in the college woodlot and farm.

Great interest and enthusiasm is everywhere shown among farmers along the line of this woodlot work.

In order to bring the possibilities of forestry more clearly before the land owners of the state I recommend the establishment of model forest plantations, made up of various species on different soils and sites. This work could be carried on by cooperating with the land owners; they furnishing the land and the department furnishing the trees free of charge. In accepting the trees the applicant should agree to care for and protect them for a period of years.

Not until demonstration work of this kind is taken up and carried forth with energy will the land owners realize the possibilities of profit in the proper care and culture of their forest lands and waste places.

COLLEGE FORESTS.

The boundaries were run on the 42,000 acres owned by the college in Iosco and Alcona counties during the fall and winter and rough estimates were made of the standing timber.

COOPERATIVE WORK.

In cooperation with the Experiment Station the department has taken up the study of the preservative treatment of fence posts; 24,688 fence posts have been received and are undergoing treatment.

At the state fair grounds in Detroit and Grand Rapids forest exhibits of plantations and seed beds have been installed and are thriving.

In order to cooperate with the U. S. Forest Service in the creation of a national forest within the boundaries of the state, a map setting forth the public lands in the following eleven counties was prepared by the department and sent to Washington: Alcona, Alpena, Cheboygan, Presque Isle, Roscommon, Ogemaw, Otsego, Crawford, Oscoda, Montmorency.

Mr. O. H. Stabler of the Forest Service was detailed to make preliminary examination of the lands in question and reported favorably upon withholding them from sale and entry for forestry purposes.

For demonstration and exhibit purposes the following donations have been made to the Department:

30 Axe heads, Simmonds Hardware Co.
6 Axes with handles, Kelley Axe Company.
26 Saws, E. C. Atkins Co.
45 Saws, Henry Disston & Co.
1 Saw-set, E. C. Atkins Co.
4 Saw sets, Henry Disston & Co.
1 Saw swage, Hanchette Swage Works.
1 Pruning knife, Kansas Pruning Knife Co.
2 Portable Saw Mills, American Saw Mill Machinery Co.; DeLoach Mill Machinery Co.

Maps and Diagrams, Hermance Mfg. Co.; Lidgerwood Mfg. Co.

Letters of inquiry from parties desiring information upon Forestry matters are constantly on the increase; 4721 letters having been sent out since October 1st, 1907.

Very respectfully,
J. FRED BAKER,
Professor of Forestry.

East Lansing, June 30, 1908.

REPORT OF THE DEAN OF ENGINEERING.

Dr. J. L. Snyder, President, M. A. C.:

Dear Sir:—I present to you, herewith, the report of the Dean of Engineering for the fiscal year ending June 30, 1908.

I entered upon the duties of my position on June 18, 1907. During the summer my attention was given largely to the work of equipping the new engineering building with furniture and otherwise preparing it for occupancy and use in the instruction work of the year to follow. In this work I was assisted by Professors Vedder, Sawyer and Newman whose requirements were consulted and met so far as possible. The actual work of installing furniture and other equipment was not begun

until September 1st and at the opening of college on the 25th of the same month the building was in a measure ready for use but the furniture was not wholly in place until after January 1st of the present year and the placing of apparatus equipment has been going on most of the time since occupancy began.

The building was formally dedicated on June 22, 1908, the principal feature of the exercises being an address by Dr. R. C. Carpenter, '73, of Cornell University, on the subject "The Education of an Engineer." This address is printed *verbatim* at the end of this report.

The building has added materially to the space and facilities for carrying on the work of the engineering departments. Some idea of its usefulness may be gathered from the statistics presented in Table I which shows the number of student-hours of work handled in each term of the year past.

Table I.

Student-hours of Instruction in Engineering Hall for the College Year, 1907-8.

Subjects.	Fall.	Winter.	Spring.
Civil Engineering	1006	1207	1269
Drawing and Design	2647	2812	1654
Electrical Engineering	331	267	217
Mechanical Engineering	1554	1409	1349
Mathematics	1865	1386	1974
Physics	730	1204	1097
English	56	642	184
Totals	8189	8927	7744

Department.	Fall.	Winter.	Spring.	Average.
Civil Engineering & Mathematics	2871	2593	3243	2902
Drawing and Design	2647	2812	1654	2371
Electrical Eng. and Physics	1061	1471	1314	1282
Mechanical Engineering	1554	1409	1349	1437
English	56	642	194	297
Totals	8189	8927	7754	8289

Table I also shows that some space was utilized by the English department, and considerably more by the work in mathematics and physics which are allied organically with the departments of Civil Engineering and Electrical Engineering respectively.

Some of the instruction given in the building in mathematics, physics and drawing has been for students in agriculture and home economics.

The floor space in the building, exclusive of the halls, toilet rooms, and library have been assigned to the several departments as follows:

Table II.

Civil Engineering and Mathematics	9730
Drawing and Design	9570
Electrical Engineering and Physics	11950
Mechanical Engineering	9420
Total	40670

With the reservation that recitation and lecture rooms are assigned by the Dean as the several interests to be served shall seem to warrant when the program for each term is published.

A drafting room on the top floor and the cement laboratory on the ground floor have not yet been equipped, and the library has not been opened for use as such, although the furniture is in place.

The vacant drafting room is used at present as a store room for the general college library. The cement laboratory will be equipped during the coming year, and arrangements will be made for the use of the library by transferring to it the engineering periodicals from the general library and the technical books of the several departments together with some from the general library.

It appears that the building is already well occupied and in fact some department rooms are inadequate for their purposes. Before very long the building will be overcrowded and provision will have to be made for physics work elsewhere, as well as for other work now conducted in the building, or the building itself must be enlarged.

The old mechanical building is now used exclusively for shops, the following changes having been made: 1st, the east wing is now a single room devoted to foundry work. 2nd, the machine shop has been extended to occupy the old drafting room and offices of the first floor. 3rd, the wood-working department occupies the entire second floor. 4th, the forge shop occupies the space formerly used for wood turning and engineering laboratory. 5th, wash and toilet rooms have been placed in the old engine room.

These changes add materially to the space for shop work, but the arrangement, especially for wood working, is not ideal and eventually new shop buildings must be erected.

The enrollment of engineering students for the year past is 485, distributed in the several classes as follows:

Table III.

Seniors	47
Juniors	63
Sophomores	92
Freshmen	174
Sub-freshmen	100
Special	9
Total	485

The number graduated was 45.

The enrollment of engineering students from 1885 to the present time is shown in Plate I. I estimate that the enrollment in engineering students for the ensuing year will be 600 students. The number of teachers giving their whole time to instruction in engineering subjects during the year is as follows:

Table IV.

Department.	Teachers.
Civil Engineering	5
Drawing and Design	3
Electrical Engineering and Physics	3
Mechanical Engineering	10
Total	21

In addition, teachers of these departments, have given instruction in general subjects to students in other courses than engineering, using room and equipment of these departments as follows:

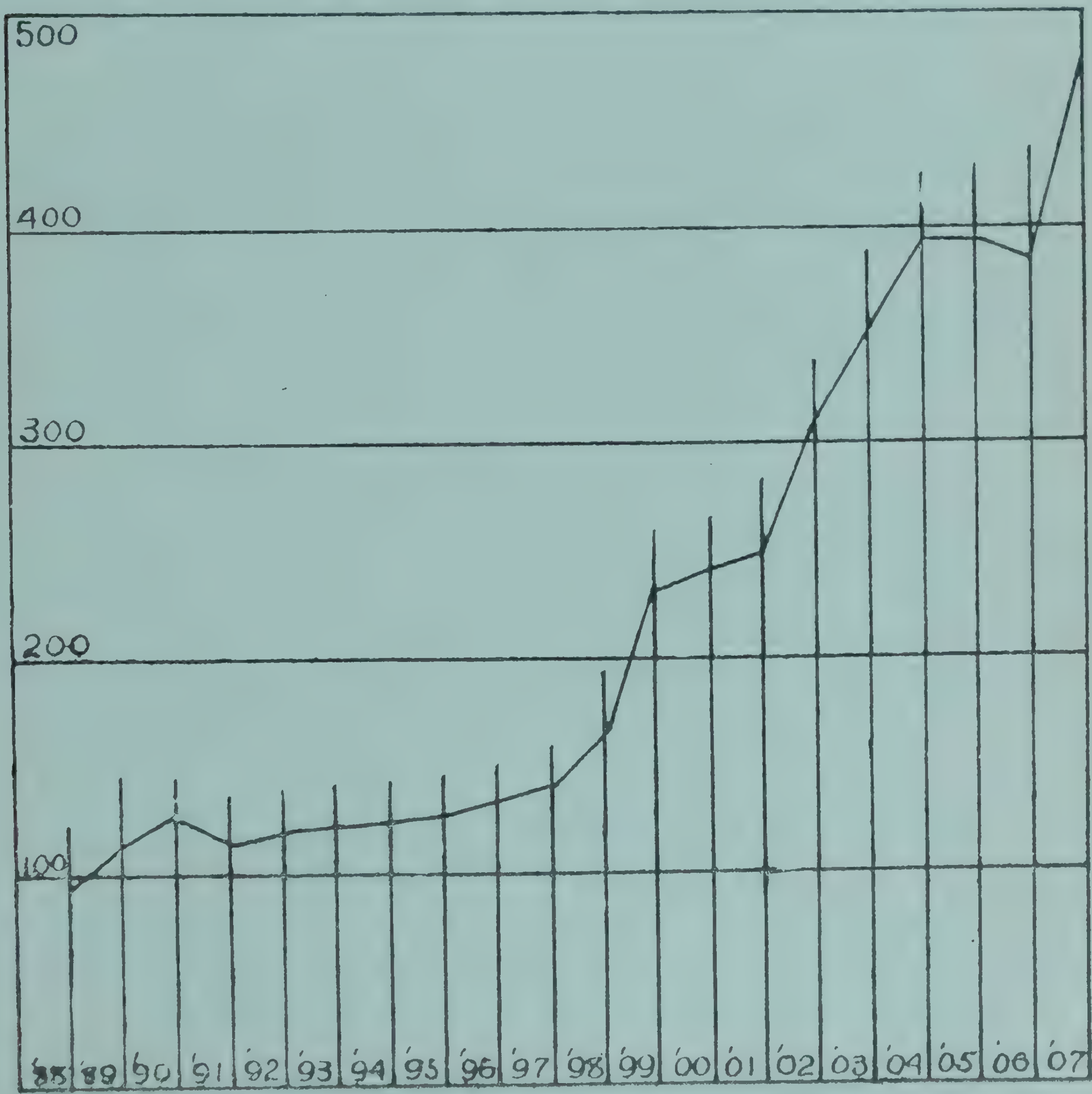


Table V.

Department.	Teachers.
Drawing and Design	1
Electrical Engineering and Physics	2
Total	3

And, also, the instruction in all subjects in mathematics has been administered from Engineering Hall and a portion of the instruction given in the building, this work requiring six teachers not included in the above enumerations.

The personnel of the engineering teaching force is as follows:

CIVIL ENGINEERING AND MATHEMATICS.

H. K. Vedder, Professor.
W. B. Babcock, Associate Professor.
S. C. Hadden, Instructor.
C. Gunderson, Instructor.
A. E. Jones, Instructor.
G. James, Instructor.
W. B. Wendt, Instructor.
W. R. Cornell, Instructor.
J. T. McVey, Instructor.
G. A. Heinrich, Instructor.
C. A. Pierce, Instructor.

DRAWING AND DESIGN.

C. Newman, Assistant Professor.
Caroline L. Holt, Instructor.
C. H. Harper, Instructor.
W. H. Perkins, Instructor.

ELECTRICAL ENGINEERING AND PHYSICS.

A. R. Sawyer, Professor.
W. L. Lodge, Instructor.
C. W. Chapman, Instructor.
E. N. Bates, Instructor.
W. H. Wadleigh, Instructor.

MECHANICAL ENGINEERING.

G. W. Bissell, Professor.
L. L. Appleyard, Assistant Professor.
J. A. Polson, Instructor.
A. C. Mehrtens, Instructor.
L. L. Chappelle, Instructor.
E. C. Baker, Instructor.
A. P. Krentel, Instructor.
W. R. Holmes, Instructor.
C. C. Wilcox, Instructor.
A. Smith, Instructor.

The College, as well as the engineering departments, mourns the death of Prof. W. S. Holdsworth, whose manhood and ability as teacher and artist left an indelible impress on his neighbors, colleagues and students. Prof. Victor T. Wilson, Pennsylvania State College, has recently been appointed Professor of Drawing and Design. In the *interim* Prof. C. Newman has been in charge of the work. His long association with Professor Holdsworth in the work of the department, and his knowledge of the details of the work and his conscientious interest have made his services of great value during the year. He will continue his connection with the department.

A revision of the course of study in engineering has been undertaken and the revised course to the end of the sophomore year has been published in the catalog recently issued.

The changes are not radical but are made to remove certain incongruities and to equalize the work of the various departments in the three terms of the calendar. The fundamental idea of a general engineering course, strong in foundation studies and broad in general features will be maintained. It is thought that such a course better fits our students to take up engineering work as it comes, than would a series of highly specialized courses in the several branches of engineering. The records of our graduates are strong confirmation of this policy.

Regulations have been enacted by the faculty by which graduates of the engineering course in this college, who have proven their ability in the practice of engineering may be granted professional engineering degrees. The details of the regulations are set forth in the catalog.

I cannot conclude this report without calling your attention to a matter which vitally concerns the engineering work at this institution, not to say the work of the college as a whole. I refer to the salaries of the instructing staff and the amount of teaching work required of them.

SALARIES OF THE INSTRUCTION STAFF.

While the institution was yet small as measured by the enrollment, the heads of the departments could and did know the students individually and the students received the impress of strong men, a condition promotive of high efficiency in college work. There were then very few teachers of instructor grade. With the growth of the college, the necessary expansion of the teaching force has been made by employing instructors and assistants at low salaries, which in engineering and related subjects, has unavoidably resulted in securing many men of entirely inadequate experience or faculty for engineering teaching, and whom, after training to our needs, we could not retain, on account of superior inducements offered elsewhere.

TABLE 6.—*Instruction staff.*

Year.	Number and grade.			Average yearly salaries.			Students enrolled.	Annual income.
	Professors.	Assistant professors.	Instructors.	Professors.	Assistant professors.	Instructors.		
1885	10	2	....	$1,770 00	$1,000 00	....	173	$65,060 00
1889	11	2	7	1,975 00	1,350 00	$650 00	....	67,306 00
1895	11	7	6	1,954 00	1,070 00	633 00	....	99,312 00
1900	12	10	12	1,866 00	1,255 00	743 00	....	184,973 00
1902	11	10	19	1,909 00	1,355 00	680 00	....	205,081 00
1904	15	6	29	1,906 00	1,233 00	684 00	....	208,373 00
1906	16	5	40	1,975 00	1,340 00	773 00	950	....
1908	19	11	51	2,191 00	1,306 00	825 00	1,191	325,000 00

Table VI gives certain information concerning the number, grade and salaries of the instructing force at several periods in the past twenty years or so of the college history. By way of summary it may be noted that in 1885, there were twelve professors (including assistant professors) for 173 students, or one professor for fifteen students. In the past year there were thirty professors and assistant professors for 1191 students, or one professor for thirty-nine students; the total instuction force in the past year was eighty-one, being one instructor for fifteen students. Adding to the number of professors those of instructor grade who receive as much salary as some assistant professors, there were thirty-eight high grade instructors during the past year or one for thirty-one students. A legitimate conclusion from these figures is that the efficiency of our instruction has been materially and seriously reduced.

The increase in material equipment which has been made in the period since 1885, cannot be considered as adequate compensation for the marked reduction in teaching efficiency which is shown by the large addition of teachers of instructor grade of which there were none in 1885, and of which there are now fifty-one whose average salary is only $825.00 and of whom thirty-nine receive less that $825.00. The above figures apply to the whole college, and are not uniform for the several departments. The average salary for the instructor grade in agriculture is $1,003.00, in mechanical engineering, $844.00, in civil engineering and mathematics, $800.00, in electrical engineering and physics, $880.00, in drawing, $716.00, and in all engineering departments is $812.00. The last comparison forces the conclusion that the grade of engineering instruction offered here should be materially raised, and so doing, on account of the large relative enrollment in engineering, would raise the efficiency of the institution as a whole.

To act upon the suggestive facts above set forth would of course increase the salary budget but we are behind many other state institutions in the matter of average salaries in all grades as well as in the percentage of total income expended for salaries.

The Carnegie Foundation for the Advancement of Teaching has recently issued a bulletin on "The Financial Status of the Professor in America and in Germany" from which it appears that of 46 state colleges and universities expending more than $45,000.00 annually for salaries, there are only three institutions which spend 34 per cent only,

or less of their total income for salaries, this being the percentage for this institution. The average percentage is 53. Also 29 institutions pay the same or a smaller salary than we do to full professors, 6 to assistant professors and 10 to instructors, the average salaries for the respective grades in the 46 institutions being, $2,201.00, $1,414.00 and $961.00. Also, there are 20 institutions for which the teaching salary expense per student enrolled is the same or less than for this college, viz.: $161.00, the average being, $176.00.

These figures, after making all allowances for varying conditions, are significant and point forcibly to the necessity of increasing the salary budget for this institution, both as a total and as a scale for the several grades, if we would maintain our reputation as a high grade institution.

The ideal scheme of salaries should include a plan of promotion in the several grades, so that new men would know what prospects are before them if they render satisfactory service. Under present arrangements at this college we frequently cannot attract desirable men, not only because of low initial salaries, but also because of indefiniteness of reward for good effort.

After a careful consideration of the whole question I suggest the following scale of salaries as appropriate to this institution:

Instructors: First year, $900; second year, $1,050; third year, $1,200; fourth year, $1,400.

Assistant Professors: First year, $1,600; third year, $1,800; fifth year, $2,000.

Professors: First year, $2,500; third year, $2,750; fifth year, $3,000.

I also suggest that the number of teachers of instructor grade be kept down to one-half the total instruction force and that a substantial increase in the number of men of assistant professor grade be made for the engineering work at this college.

"The ideal professor is the man who knows his subjects not merely as they exist in printed rules or texts, but as they have lived and grown, in his thoughts and have been tried by his practice, a man whose fund of information is large and whose professional experience has led him in broad lines. He is not only a masterful teacher, a leader of thought in the field he represents, but is one able to stand among professional men and aid in their discussion of practical problems. * * * * * * The presence of one or two fine men, however, is not sufficient for the modern state college of engineering, but in these later days the staff must be strong numerically as well as individually."—Dean W. F. M. Goss, College of Engineering, University of Illinois.

AMOUNT OF TEACHING REQUIRED OF MEMBERS OF THE INSTRUCTION STAFF.

"The effect of engineering research is so great in stimulating the activities of professors and students, and in maintaining correct ideals with reference to all things mechanical, that no state college of engineering is to be regarded as performing its full function, which fails to devote a portion of its energies to such investigations."—Dean W. F. M. Goss, College of Engineering, University of Illinois.

This opinion is the concensus of all engineering educators and, judged by it, the engineering work at this college is weak. To repair the weak-

ness requires that the teaching and other routine duties of some men in each department should be adjusted so as to permit them to undertake and direct investigation work in much the same way as is now done in agricultural lines where the state college and the experiment station are in the same institution. It is to be hoped that the McKinley Engineering Experiment Station Bill, now pending in Congress, or its equivalent will put us in position to take up investigation work actively and usefully. In the meantime it is imperative that some work of this kind be instituted and consumated in order to infuse into our work a real spirit of enthusiasm such as numbers and material equipment alone can not give to us.

To sum up the whole question of engineering teachers we need more money for men, enthusiastic men, gifted for teaching and scientific work. With such an endowment the work will produce results of untold value to our students and the institution. Without it there is only discouragement for all concerned.

In conclusion I desire to express my appreciation of the hearty cooperation of the college authorities and of the engineering staff which has been given to the Dean of Engineering during the past year.

Respectfully submitted,

G. W. BISSELL,

Dean of Engineering.

East Lansing, Mich., June 30, 1908.

THE EDUCATION OF AN ENGINEER.

ROLLA C. CARPENTER, LL. D.

Address at the dedication of Engineering Hall, June 22, 1908.

Engineering can be defined as an application of the laws of nature as revealed by a study of the physical sciences to the practical and useful arts. It deals with all branches of industry which are founded on or related to the physical or chemical sciences, and is divided into numerous branches depending upon the field of application.

In very early days such engineering as was practiced related solely to the art of war. Even in the days of the Romans the art was considerably advanced and the military engineer was a man of great importance. He was depended upon for and produced plans of fortifications and instruments of warfare, many of which even at the present time would be considered as showing considerable knowledge of the properties of materials and the laws of action of mechanical forces.

As time progressed the demand for public works and large constructions such as light-houses, roads, docks and apparatus for handling heavy machinery led to the development of a class of engineers whose productions were devoted to civil rather than to military purposes. These engineers were distinguished from the military engineers by the term "Civil."

The term "Civil Engineer" included practically all members of the profession not carrying on military work until approximately 50 years

ago. At about that time there was a further subdivision of the profession into special branches, as for instance Mechanical and Mining and in later times Electrical.

The latter subdivisions have become of great importance during the last 20 years, because of the great development of the manufacturing and electrical industries in this country.

The mechanical and electrical branches have created special fields which are now well recognized by the engineering profession generally. It is also interesting to note that the development of these branches has acted to practically limit the term "Civil Engineer" to a specialty as narrow as the other branches. Thus at the present time while the term "Civil Engineering" might in its broad sense cover all branches of engineering not military, as a matter of fact the actual civil engineer is one educated for special work and generally with a practical training for only one branch of engineering.

Neglecting military engineering, we find that in the field of education there is broad recognition given to the professions of Civil, Mechanical, Electrical and Mining engineering; in addition special branches of engineering comprehended by a single industry are also often recognized.

Considering the various branches of engineering as they exist to-day, the fields of industry covered are practically as follows:

Civil Engineering: Devoted principally to surveying, construction of static structures, bridges, dams, etc., and to public works.

Mechanical Engineering: Devoted principally to dynamic structures, including machines, engines of all kinds, construction of machinery and factories, and operation of works.

Electrical Engineering: Devoted to the application of electricity, principally to mechanical engineering constructions. (This is generally considered a branch of Mechanical Engineering and in most institutions there is a tendency to bring the mechanical and electrical engineering courses together except for certain special studies.)

Mining Engineering: Application of engineering to mining operations. It includes surveying, assaying, mining processes and machinery.

The number of sub-branches of engineering relating to the special industries can it is evident, be as numerous as the industries themselves. Among the sub-branches of engineering mainly mechanical which are organized into national societies may be mentioned heating and ventilating, marine, automobile, electric railroad, railroad master mechanics, sanitary, etc.

From the above it is noted that these various branches of engineering differ from each other principally as to the field of application and the character of industry dependent thereon.

The above statements tend to give an idea of the work required of an engineer. It is to be noted that this work covers nearly the entire field of human activity. It is an engineer's business to *understand* and *control* the *forces of nature*. We owe all our great productions in practical lines to the engineer; it is he who designs and takes in charge the construction of our bridges, our railroads, our engines, our electrical machinery and all the great practical applications of science.

There is a difference between engineering and invention; invention, in order to produce practical results, may require the services of an engineer and may involve engineering but nevertheless the work of an

engineer is materially different from that of an inventor. The difference is so great that it is rare to find that a great inventor has the practical instincts or the ability to produce practical results which must be possessed by the great engineer. No college course could safely undertake to give instruction in the "art of inventing" if any such art can be said to exist, but it should instruct in the underlying sciences whose field of application if extended into new domains might lead to discoveries which we term invention. It is true, that many engineers in carrying out engineering work have had occasion to take out patents or to make what might be termed a minor invention; but this class of invention is more in the nature of design, and while in many cases it may have proved remunerative it pertains rather more to the field of engineering than to the field of invention.

While engineering does not necessarily include invention, it is in many respects closely allied. An invention may be defined as a discovery in the application of the forces of nature which results in the production of new machines or new processes. Engineering makes the discoveries of the inventor of practical use by giving shape and proportion to all the parts and reducing the invention to a practical and useful form. The engineer extends the field of practice by experiment and research rather than by brilliant discovery. In his productions, if he is not confined to the field of practice with its definite and well-known boundaries, he extends the field of development cautiously and slowly and only to such an extent as warranted by well-known theories which are proved, checked and verified so far as may be by experiments. This makes the development of the engineer's art a slow one since it is rarely ever safe or prudent to base large expenditures of money in great constructions or results of theoretical considerations unproved by practical experience.

Serious mistakes have resulted where engineers have not been content to follow the slow period of development through the natural processes of design and practical trials, one striking recent example of which is the failure of the Quebec bridge, which failure never would have occurred had the form of the bridge and the proportion of its parts been the result of a slow development instead of the application of a theory whose coefficients were developed only for lighter and smaller structures.

What an engineer does is largely the work of application of well-known laws of nature along well developed lines to fields of industry whose limits are well defined or at best are extended slowly.

The above consideration of what an engineer is *required to do* also gives somewhat of an idea of what an engineer *must know* in order to produce satisfactory results with the least waste of energy and money.

It is also evident that if an engineer is to succeed in his various undertakings, he must be an educated man and must understand the laws of nature and the method of application of these laws so far as such information can be obtained from the schools and colleges.

When the fact is considered that very few of the engineering schools have an age exceeding 50 years, it is clearly perceived that the early engineers and many of those who have performed the most noted achievements, did not possess the special college training which is now believed essential for good engineering. The early engineer often arrived

at his conclusions from studies based on experience with similar previous constructions, and his knowledge of the laws of nature obtained perhaps in unsystematic and laborious ways and often imperfectly, but obtained in some manner, was sufficient to enable him to design and produce constructions which while safe and reliable did not extend the field of practice to any great extent.

As illustrating the achievements of the early engineers without a general college training it will suffice to mention James Watt, who is often classed as a great inventor. A study of Watt's life, experience, and so-called invention must lead to the conclusion that his work was principally engineering and the success which the steam engine attained under his hands was due more to the engineering processes of construction and development than to the fact that its condenser was separated from the engine cylinder. Watts was perhaps as well trained for this work as any man at that time living, since, although not a college student himself, he had all the benefit which could arise from the use of the scientific apparatus of Glasgow University and the advice of the most scientific men of his time. The practical results which he produced were largely due to the engineering improvements brought about by the use of better tools and better workshops and the training of workmen in the art. As illustrating the low state of the engineering art at the time of Watt, I may mention the fact that Watt, after three unsuccessful trials in the casting of a cylinder for his engine, expressed himself as greatly elated when a cylinder was secured which was not more than ⅛ inch out of round. The engineering genius of Watt and his associates overcame such difficulties and the development of the steam engine, which was in his hands extremely rapid, was assured more, by engineering advances and developments than by invention.

From the consideration of what the engineer is required to do, much light is thrown upon what he must know and some of the fundamental things which he must study.

It is evident that if he must make application of the laws of nature he must be familiar with them to as great an extent as possible. In colleges these laws, which are of principal value to the engineer, are taught under the head of Physics and Chemistry. It is at once evident that in some branches of engineering the composition of materials and the internal molecular laws governing such composition as taught in Chemistry may be of little importance whereas in certain other branches of engineering the laws of nature as revealed in Geology and Mineralogy may become of great importance.

The engineer must also be familiar with the tools for using and applying the laws of nature; hence he must know mathematics. Mathematics are the tools necessary in all computations, estimates, and all the preliminary engineering calculations essential for the production of a successful result.

Fundamentally, then, the basis of all engineering studies is a training in

Mathematics,
Physics,
Chemistry.

I lay great stress on these particular studies for they are often distasteful to the student, for the reason that he does not perceive any

immediate practical use and does not like to put forth the hard mental work required to master and understand them. I wish to state to such students that in my opinion these fundamental scientific studies are the most important in a practical way of any taught in the engineering courses. One reason which makes them of great importance is this fact that the fundamental studies are usually of such a nature that if they are not acquired in college they will never be acquired in after life. The practical application of these fundamental studies gives us our various engineering courses and if one is well grounded in the fundamental studies the practical applications can often be obtained as well or better outside of a college course as in the course. To an engineer, the most important of all fundamental studies is without doubt mathematics. It is true that many noted engineers have succeeded in certain lines of work without the use of much mathematics; but it is not certain that even in those lines of work they would not have succeeded better and produced better results had the training in mathematics been better.

I feel sometimes that a few engineers have decried the advantages of the higher mathemetics simply because they have not been required to practically apply them to any great extent, and they have entirely overlooked the fact that the logical training produced by the study of mathematics has been to them of great practical use even though many of the applications have been unused.

The hard beaten and closely defined paths of mathematics give little opportunity for flights of the imagination or the poetical dreams of fancy. However, its logical methods produce precision of thought, accuracy of statement and soundness of conclusions without which an engineer could not produce useful or practical results.

I should also add as a fundamental study for an engineer, English since there is no profession so much dependent upon description as relating to the development of any engineering work in question, the probable expenses and the financial results produced. It is perhaps fair to state that few engineers have succeeded who are not to a great extent masters of their mother tongue. They might be deficient in the art of spelling without serious detriment, perhaps, but not in the art of speaking or writing if they succeed as engineers.

For these various reasons, English should occupy an important place in the course of every American engineering college. A criticism of many of the English studies taught in our colleges can be made on the ground that they are not confined to teaching students how to use the English language but on the other hand, waste the time of engineering students by taking up matters which although of interest to the specialist in language, is of no earthly value to a man who merely needs to learn its use.

It is necessary that an engineer should know how to apply the fundamental studies of a college course so as to produce practical useful results. To secure that end, students in college courses should be trained by lectures, recitations and laboratories in the application of mathematics, physics, chemistry and English to the various specialties which they propose to master as a preparation for their future work. These specialties I will not discuss in this place, since they must necessarily differ in different colleges with the time available for instruction, con-

veniences at hand in the laboratory, and various surrounding circumstances.

The student should also be expected to obtain a certain amount of manual training which shall give him skill in the handling of the instruments of his profession, and it is right and necessary that he should become practically familiar with surveying instruments, shops tools and drawing instruments, and should have as much practice as the time at hand will give in those particular branches.

In my opinion the practical training which is obtained in the shop, drawing room or surveying is valuable to any engineer even though his line of practice may take him into other fields. I believe that an engineer should be trained in as many of the practical branches of the art he is to follow as possible, while he is in college, although it is doubtless that such training could be obtained in greater amplitude after the college days were over, in a practical profession. The college training has the advantage over the special training obtained later that it is generally broader and more fundamental, and it is given the student as an application of principles which have been enunciated in text books and laboratories. It presents the matter from a field of view different from that of later life and one which is more beneficial, since it involves the method of application of theoretical principles giving a broader and more general culture.

It is unquestionably desirable for the engineer to know foreign languages, philosophy, economics, history, etc., for the same reason that these studies are desirable for any educated man. These studies will doubtless give him a broader view of life and a culture desirable for an engineer to have and unattainable without them. The practical question which is of great importance respecting this class of studies is the amount of time that can profitably be devoted to them.

The engineering courses as they are at present constituted require four years of a student's life and have very few of the so-called culture studies as enumerated above. The tendency of recent times has been to reduce rather than increase the number of so-called culture studies because of the pressure to give the student more technical work in his college course. This desire to make the student practically familiar with nearly all the applications of engineering principles to the various engineering industries has led in late years to the introduction of a great many special studies and I am afraid in some cases to the reduction in time which had previously been given to the fundamental studies, especially mathematics and its application to physics in the broad fields of mechanics and hydraulics.

My own impression from a long experience with the education of engineers is that we have carried this application to special studies somewhat too far in many instances and by so doing have weakened rather than strengthened the engineering student. It is my opinion that the fundamental studies well and thoroughly taught, together with methods and practice in application to the principal engineering processes, give us better educated and more capable engineers than the forcing of students through a long list of studies of application, to each of which can necessarily be given only a limited time. This raises the question as to whether or not we have improved our systems of engineering education.

It is frequently claimed that the old fashioned engineering course of 30 years ago with its limited number of subjects did produce engineers as good and great as those which are now educated in the modern engineering college with its more complete course and its highly developed and organized laboratories, and that this fact constitutes an argument against our present elaborate equipment and course. It is probable, however, that the engineer educated in the college of 30 years ago could not compete or hold his own under the same conditions with the recent graduate of the engineering course. The men of to-day are better and more thoroughly trained both along general and fundamental lines of engineering as well as in the special applications. It is not to be doubted that the engineering school of thirty years ago produced many successful and great engineers. The greatness of a man in any profession is in a large measure dependent upon his opportunity, the amount of competition and the surrounding conditions, so it is not certain that under different circumstances, limited opportunities, and greater competition, the earlier and less educated engineer would have succeeded so well. Hence a comparison of the work done in different generations is hardly a fair one from which to draw conclusions as to the value of an educational training. It is my own opinion that the engineering college course of to-day produces better trained men than the course of thirty years ago. These men are not only better trained but they are better able to solve the engineering problems which arise and in many cases are producing results not dreamed of or considered possible thirty years ago. I am, however, of the opinion, that the college engineering courses will become more successful as they increase the thoroughness of training in the general fundamental studies and as they make the students thoroughly understand the application of the fundamental principles to practical construction. For this latter purpose extensive laboratories, shops and drawing rooms are required, since it is impossible in practical life to secure the training and its method of application in a broad and fundamental manner to practical constructions.

While engineering is founded upon the application of the laws of nature, as expressed in various sciences, it also depends to a great extent upon the results of experiment and research. The immutable laws of nature call for a perfect mode of operation and perfect materials to produce theoretical results. Such materials are not to be found by the engineer. No operation conducted by man is perfect; as a consequence all results fall short of the theoretical. The engineer must know how close to the theoretical results he can reach in actual practical construction. Such knowledge comes only from research and experiment which gives coefficient and constants which enable him to calculate with reasonable certainty how far the practical results will deviate from the theoretical. This indicates that an engineer's knowledge must be a combination of the theoretical and the practical, and that he must make both branches of knowledge harmonize with each other or his results will be unreliable and uncertain.

The question has been frequently raised, especially during the last year or two, particularly by our friends who are interested in education along the so-called classical courses, as to whether or not the engineering courses afford sufficient studies to make the engineer a broadly

educated man. Such discussions have been of intense interest to engineers and they have generally conceded that additional so-called culture studies in history, economics and philosophy would doubtless be desirable for the engineer, although I do not know that any engineer has admitted that mental discipline of high value was not obtained in the arduous mental work required to complete the various engineering studies. It is also interesting to note in this connection that the engineering college course has obtained an excellent reputation as being of great value to men having business interests of any kind, and this has been one of the reasons why there has been during the last few years, such an increase in numbers in the engineering courses and a corresponding diminution in the old classical courses. I am certain that Sibley College has graduated in its engineering course many students who never expected to be engineers but who took the course believing that the combination of theoretical-practical training would give them culture of a useful kind which would be of more benefit to them in business than that obtained in any other course. As indicating how prevalent such sentiments are, I merely quote a few words from a recent letter of a graduate in our course of mechanical engineering:

"I am intruding further upon your time only to say that since 1896 I have been permanently located in Toledo, engaged in real estate development. My technical training, however, stands me in good stead in the work I have to do, and I seem never to lose the deep interest I have aways had in mechanical matters."

It has even been proposed to increase the length of the engineering course by requiring additional studies along the lines of philosophy, economics, history, etc., and such a proposition has been received with considerable favor by most of our engineering papers and by a few of the engineering colleges. This proposition if accepted would require the students to spend an additional year in obtaining what are frequently called culture studies before taking up the technical work. The objections which have been urged to such requirements are mainly those of a practical nature. It is not, for instance, certain that many students who are now able to take the engineering courses could afford either the time or money for the additional culture studies which have been suggested. It is not certain that even if these additional culture studies were taken the men would become better engineers or that they would be better trained for performing any work which engineers are required to do. It is generally considered a calamity if a man is kept in college too long. The effect of too long a course is to dampen his enthusiasm and reduce the energy which is necessary in order to obtain and successfully prosecute engineering work.

There is danger as well as benefit in the proposed addition to the engineering course and for that reason the large engineering colleges are proceeding cautiously in increasing the length of the course although generally agreeing as to the advantage of the additional year for the broader training.

The engineering courses during the last thirty years have been greatly advanced in colleges principally by increasing the entrance requirements. As an illustration, the entrance requirements for the courses in Sibley College take two more years in high school at the present time than

in 1890. At the present time two years of foreign languages, one year of English, one year of mathematics, in addition to that required in 1890, are required at entrance. The fact that such an increase in requirements is possible indicates great improvement in the work done by the high schools during this period. It also makes it possible to give the students much more technical training. The experience at Cornell indicates that studies of the nature of foreign languages and English are taught with better results in the high school than in the university. This is probably also true of geometry and trigonometry, but possibly not so true with respect to advanced algebra and other studies which require well developed reasoning powers on the part of the students.

It is, I think, universally conceded that a college course should not compete with home schools in the education of students, and that the requirements to colleges should be based on the possibilities of obtaining trained students in the various home schools. For this reason the location of a college must have much to do with the requirements for admission, since the college work naturally should begin at the point in a young man's educational course where the training of the preparatory school is completed.

I have intended to convey the idea in the foregoing discussion that the work of the engineer is one of great responsibility and requires thoroughly trained minds as well as natural ability. Considering the engineering profession as compared with others, in my opinion it is the most important from all points of view of any. Financially, it controls practically all expenditures for material improvements of any kind. It deals with sanitary, life-saving structures, and with every mechanical construction productive of better health and increased life. It deals with the production of manufactured articles and consequently the demand for engineering work must increase so long as the industries of our country improve.

From these various facts, the importance of engineering schools appear obvious since without them we could not have properly trained and qualified engineers, and without engineers little material progress of the world could be made.

I have not touched in my discussion on the subject of what is termed "industrial education," which is generally defined as one which will provide for the world its supply of skilled mechanics in various lines.

This branch of education is one of extreme importance and at the present time it is scarcely developed to any great extent. Until very recently schools for such lines of education were not needed because skilled mechanics could be trained as apprentices in the various work shops. The tendency of trade unionism is to kill the apprentice system without supplying a substitute for it. At the present time there is an actual scarcity of skilled men due to this condition of affairs and it has been proposed as a remedy to educate workmen and give them skill in special schools. It seems probable that the demand for these schools will at no distant time lead to their formation in nearly all the large cities.

It is evident that a course of study for such a school would be very different from that for engineering and would involve what is commonly known as a grammar school course combined with a shop course

where a student would remain long enough to acquire skill in the special trades in which he desires instruction.

It is obvious that my remarks have not been applicable to schools of this character.

After this general discussion as to the education of an engineer, it is a matter of some interest to note what this institution has contributed along these lines, as well as to consider what it is doing and what it is likely to do.

This institution, I am happy to say, has always been a leader in educational methods and has occupied a prominent position in the world of education during the entire period of its existence. It has especially been the leader in a certain form of industrial education and was the first to point out methods of applying scientific processes to the material advancement of the greatest industry of our country. In connection with the early work of this institution and preceding the establishment of mechanical or engineering courses, it obtained because of the excellent work done here, a reputation for scientific research unsurpassed in the annals of the educational world, which reputation has been increased by the excellent work of the last few years.

It was my own good fortune to be a student here some thirty-five years ago and when the total enrollment did not much exceed 100 students, and in later years, after graduating as an engineer in our neighboring university, I was called back as one of the teachers to aid in the preliminary development of an engineering course. While I have not been in close personal contact with the work here during the past eighteen years, I have been in position to know in a general way what has been done and I now congratulate the college, its officers and students, for having passed through the period of development and having entered upon the period of production which is now so auspiciously inaugurated by the new structure with which your State has so generously endowed you.

It is a great step in the line of material improvement and advancement since the time when I first saw the institution and became acquainted with its officers and students. As the epochs of improvement which have marked the successful progress of the institution from period to period are matters of history and are well-known to nearly every person here, it is unnecessary for me to consume your time with a repetition, and I will not refer to the beginning nor intermediate stages of the period of development which finally led to the convenient, appropriate and magnificent building and to the perfect system of education for engineers which you now possess.

This structure in its completeness, with its well equipped laboratories, class rooms, drawing rooms and shops, speaks for itself in a way more eloquent than words can express of what has been accomplished in a material way, and leads me to extend again my congratulations to the president, faculty, students and the State of Michigan for the magnificent equipment for engineering education of which you are the proud possessors.

In conclusion I desire to call attention to the well-known fact that although structures and material equipment are of great importance to the institution to which they belong, yet the real improvement on which the institution's reputation depends comes from the character and

ability of the teachers to whom the material equipment is entrusted. With poor and inefficient teaching the best equipment is of little value. On the other hand, good teaching may make great engineers with a very poor equipment.

Respecting the officers and faculty of this institution, I can happily say that they have always been men of character and reputation, and because of the work done by these men the institution owes the advanced position which it occupies to-day. The work of a college is in a very large measure influenced by the character of the president, and it is very nearly impossible for a college to succeed when the executive office is weakly or badly administered. In this respect your college has been it seems to me, remarkably fortunate. It has been my good fortune to know personally and quite intimately four out of the six presidents which this institution has had. All of these men have been of great ability and thoroughly devoted to the interests of the institution. The second president, T. C. Abbot, administered the affairs of the college for a long time successfully and carried the institution through periods of development during which time its life and stability were threatened and until its value as an educational institution was fully recognized. He was a man beloved of all and doubtless all here are familiar with the history of his administration.

The present administration has been one of signal, material development, during which time the number of students has trebled and the property and material equipment of the institution have been greatly improved and enhanced in value.

I am delighted that the necessity for engineering education has been recognized and that so much has been done to upbuild a strong engineering department.

For the future I can only predict that good results and a steady growth are certain and that the engineers from this institution will make a reputation for the course which will bring additional students and give to the Alma Mater glory and renown.

REPORT OF THE DEPARTMENT OF MECHANICAL ENGINEERING.

Dr. J. L. Snyder, President, Michigan Agricultural College:

Dear Sir:—I present, herewith, my report as professor of mechanical engineering for the year ending June 30, 1908.

In the teaching and administrative work of the department I have been assisted by Prof. L. L. Appleyard, Messrs. Polson, Mehrtens, Chappelle, Wilcox, Krentel, Smith, Holmes, Baker and Crawford, all of whom have rendered hearty and efficient cooperation in the department work, and Miss Clara B. Purcell whose services as clerk have been of great value, owing to her familiarity with the office routine and her conscientious attention to the tasks of the office.

Tables I, II and III show the distribution and amount of the teaching duties among the members of the staff. Mr. Chappelle has resigned and Mr. C. C. Wilcox has been promoted to the position of foreman of the machine shop. The increase in space available for the shop work upon the completion of Engineering Hall was very timely and has been fully utilized.

To provide for the inevitable increased demands of the near future, additional space will be required and it should be provided by an entire new set of shop buildings. Of all the improvements in the work of the department made possible by the new building the most marked is in the provision for engineering laboratory work. In connection with the other engineering departments similarly benefitted, the engineering laboratory facilities of the college are now on something like a satisfactory footing. The portion of the general subject allotted to this department is provided for in rooms 6 and 112 in the new building and the work is in charge of Mr. Polson.

Room 6 contains a 100,000 lbs. motor-driven Riehle Universal Automatic Testing Machine and other apparatus for the testing of materials, apparatus for fuel calorimetry, and the cabinets for the instruments used in the engine laboratory.

Room 112, designated as the engine laboratory, contains 3 simple, 1 compound, and 1 Corliss engine, 1 steam turbine, 1 duplex steam pump, each fitted with independent surface condenser and prony brake or other device for measuring out-put; gas and hot engines, injectors, calibration apparatus for indicators, gauges, etc.; experimental hot blast ventilating apparatus, water motors, etc., all connected up permanently and ready for use on short notice. Steam at from 90 to 150 lbs. pressure is supplied through an underground main from the college power house.

Boiler tests are made in the college power house.

Believing that shop work and machine design are essentially coordinate subjects, they have been placed in charge of one member of the staff, Assistant Professor Appleyard. The idea is not new, having been embodied hitherto in the practice of Mr. Leonard for several years.

The extensive experience of Mr. A. C. Mehrtens in gas engine practice has made it possible to offer courses in gas engine theory and design adoption in the general subject of machine design.

In the revised course of study shop work will be uniformly eight hours work per week in all terms for the purpose of simplifying the keeping of records and the construction of the program of work for each term.

It would be desirable to arrange so that the shop work quota of eight hours could be given to each student in a continuous period except for a recess at noon, but at present there are serious difficulties in the way.

Courses in heating and ventilation, power station design and business methods have been introduced experimentally with results so encouraging as to warrant them as permanent features of the course.

The theoretical work in Strength of Materials has been transferred to the civil engineering department, since it is really a part of the general subject of analytical mechanics already taught by that department.

The spirit of cooperation existing between this department and the other engineering departments is all that could be desired and promises well for future progress and usefulness. The student spirit is also encouraging.

Respectfully submitted,
G. W. BISSELL,
Professor of Mechanical Engineering.

East Lansing, June 30, 1908.

TABLE No. 1.—*Class-work of department of mechanical engineering, fall term, 1907.*

Class.	Subject.	No. of course.	Teacher.	Hours per week each student.	No. of students enrolled.	Student hours week.	Classes in.
Sub-Fresh...	Woodshop............	2 m	Mr. Krentel and Mr. Smith...	10	89	890	Mechanical Bldg.
4-yr. fresh...	Woodshop............	2 a	Mr. Krentel and Mr. Smith...	10	91	910	Mechanical Bldg.
5-yr. fresh...	Forge-shop............	1 q	Mr. Holmes............	6	53	318	Mechanical Bldg.
Sophomore..	Forge-shop............	1 r	Mr. Holmes............	12	23	276	Mechanical Bldg.
Sophomore..	Foundry............	1 e	Mr. Baker............	8	32	256	Mechanical Bldg.
Sophomore..	Shop methods..........	5	Prof. Appleyard..........	2	84	168	Rm 403, Eng. Hall.
Junior......	Machine shop..........	1 g	Mr. Chappelle and Mr. Wilcox.	6	98	588	Mechanical Bldg.
Junior......	Machine design..........	6 c	Mr. Mehrtens............	6	36	216	Rm 207, Eng. Hall.
Junior......	Metallurgy............	11	Mr. Polson............	1	60	60	Rm 301, Eng. Hall.
Senior......	Machine-shop..........	1 j	Mr. Chappelle and Mr Wilcox.	6	5	30	Mechanical Bldg.
Senior......	Steam eng. design.......	8 b	Prof. Appleyard..........	6	16	96	Rm 205, Eng. Hall.
Senior......	Kinematics............	14 a	Mr. Mehrtens............	2	42	84	Rm 111, Eng. Hall.
Senior......	Experim'l laboratory....	15 a	Mr. Polson............	4	43	172	Rm 6, Eng. Hall. Rm 112, Eng. Hall.
Senior......	Graphics of mechanism..	16	Mr. Mehrtens............	4	42	168	Rm 207, Eng. Hall.
Senior......	Thermo-dynamics.......	17	Prof. Bissell............	5	48	240	Rm 109, Eng. Hall.
Totals....	....	......	....	....	752	4,472	....

TABLE No. 2.—*Class-work of department of mechanical engineering, winter term, 1908.*

Class.	Subject.	No. of course.	Teacher.	Hours per week each student.	No. of students enrolled.	Student hours week.	Classes in.
Sub-fresh....	Wood-shop............	2 n	Mr. Krentel and Mr. Smith...	8	85	680	Mechanical Bldg.
4-yr. fresh...	Wood-shop............	2 b	Mr. Krentel and Mr. Smith...	6	97	582	Mechanical Bldg.
5-yr. fresh..	Forge-shop............	1 r	Mr. Holmes............	6	47	282	Mechanical Bldg.
Sophomore..	Forge-shop............	1 d	Mr. Holmes............	12	19	228	Mechanical Bldg.
Sophomore..	Foundry............	1 e	Mr. Bake............	8	28	224	Mechanical Bldg.
Sophomore..	Machine design..........	6 a	Mr. Mehrtens............	6	50	300	Rm 207, Eng. Hall.
Junior......	Machine-shop..........	1 h	Mr. Chappelle and Mr. Wilcox	8	92	736	Mechanical Bldg.
Junior......	Machine design..........	6 d	Prof. Appleyard..........	8	31	248	Rm. 207, Eng. Hall.
Junior......	Steam-engine design....	8 a	Mr. Mehrtens............				
Junior......	Valve gears............	9	Prof. Appleyard..........	2	63	126	Rm 207, Eng. Hall.
Junior......	Boilers............	12	Mr. Polson............	2	69	138	Rm 301, Eng. Hall.
Senior......	Machine design..........	6 e	Prof. Appleyard..........	10	15	150	Rm 205, Eng. Hall
Senior......	Power station design....	21	Prof. Bissell............	6	19	114	Rm 109, Eng. Hall.
Senior......	Engineering laboratory..	15 b	Mr. Polson............	8	15	120	Rm 205, Eng. Hall. Rm 112, Eng. Hall.
Totals....	....	......	....	....	571	3,928	....

TABLE No. 3.—*Class-work of department of mechanical engineering, spring term, 1908.*

Class.	Subject.	No. of course.	Teacher.	Hours per week each student.	No. of students enrolled.	Student hours week.	Classes in.
Sub-fresh....	Wood-shop............	2 p	Mr. Krentel and Mr. Smith...	4	75	300	Mechanical Bldg.
4-yr. fresh...	Wood-shop............	2 c	Mr. Krentel and Mr. Smith...	10	91	910	Mechanical Bldg.
5-yr. fresh...	Machine shop..........	1 s	Mr. Chappelle and Mr. Wilcox	6	37	222	Mechanical Bldg.
5-yr. fresh... Sophomore..	Foundry.............. Foundry..............	1 e	Mr. Baker..................	8	27	216	Mechanical Bldg.
Sophomore..	Forge-shop...........	1 d	Mr. Holmes................	12	4	48	Mechanical Bldg.
Sophomore..	Machine-shop..........	1 f	Mr. Chappelle and Mr. Wilcox	12	57	684	Mechanical Bldg.
Sophomore..	Machine design.........	6 b	Mr. Mehrtens..............	4	83	332	Rm 207, Eng. Hall. Rm 405, Eng. Hall.
Sophomore..	Steam-engine..........	7	Prof. Appleyard...........	4	77	308	Rm 403, Eng. Hall.
Junior......	Machine-shop..........	1 i	Mr. Chappelle and Mr. Wilcox	8	116	928	Mechanical Bldg.
Junior......	Theory of design........	10	Prof. Bissell...............	2	35	70	Rm 109, Eng. Hall.
Junior......	Materials laboratory.....	13 b	Mr. Polson.................	3	51	153	Rm 6, Eng. Hall. Rm 112, Eng. Hall.
Junior......	Gas engine design.......	22	Mr. Mehrtens..............	2	43	86	Rm 118, Eng. Hall.
Senior......	Machine design.........	6 f	Mr. Mehrtens..............	6	21	126	Rm 205, Eng. Hall.
Senior......	Engineering practice....	18	Prof. Bissell...............	2	13	26	Rm 109, Eng. Hall.
Senior......	Thesis.................	19	Prof. Bissell and Mr. Polson..	10	15	150	
Totals....	....	.....	....	....	745	4,559	....

REPORT OF THE DEPARTMENT OF MATHEMATICS AND CIVIL ENGINEERING.

To the President:

Sir:—The college year just passed has produced results above the average. There have been some troublesome phases of the work, but on the whole, progress has been continuous; the organization of the department better than ever before; our instructors zealous and industrious, and the cumulative efficiency of the departmental work has reached its highest point. To render this characterization a fitting one, all teachers in the department have worked in harmony, and I wish to commend every one for his share in the general results. With the exception of the writer's name, the following list includes the names and titles of those who have formed the departmental staff during the year. There have been no resignations or withdrawals during that time.

The list is arranged in order of seniority of appointment.

Warren Babcock, B. S., Assistant Professor of Mathematics.

A. E. Jones, B. S., Instructor in Mathematics.

C. Gunderson, A. M., Ph. D., Instructor in Mathematics.

S. C. Hadden, B. S., Instructor in Civil Engineering.

G. James, A. B., Instructor in Mathematics.

W. B. Wendt, B. C. E., Instructor in Civil Engineering.

W. R. Cornell, B. S., Instructor in Civil Engineering.

J. T. McVey, C. E., Instructor in Civil Engineering.

G. A. Heinrich, B. S., Instructor in Mathematics.

C. A. Pierce, B. S., Instructor in Mathematics.

It is a pleasure to record the promotion of two teachers in the above

list. Mr. S. C. Hadden has been made assistant professor of Civil Engineering for the ensuing year, and Dr. C. Gunderson has been advanced to be assistant professor of Mathematics.

Three of the instructors named, G. James, G. A. Heinrich and C. A. Pierce, have resigned to take up work elsewhere, at the end of the college year.

With the beginning of the fall term, nearly all departmental equipment pertaining to the teaching of civil engineering was installed in quarters assigned to the department, in the new engineering building. Here we have found infinitely greater facility and convenience in the conduct of classes in technical work than ever before in the sixteen years I have been in charge of the department. But this statement should not be understood to mean that our present location is either ideal or more than adequate, and while the facilities afforded by the new building are duly appreciated, it must be apparent that their provision was deferred a long time beyond the real need for them. Nor is the laboratory space now available, convenient in some respects or large enough to comfortably receive the classes which report for instruction. The room designed for storage of instruments, assigned to classes in surveying, is much too small and inconveniently situated with reference to egress to the field. There is lacking a suitable room for experimental work with instruments of precision, planimeters, pantographs, integrators and the like.

As a matter of historical record, it may be said that the quarters now assigned to the department were not designed with reference to its needs. The writer had no part in the planning, except to express his opinion of the minimum space needed for a certain limited purpose. Until the engineering building was completed he was informed that there would be provided for the purposes of civil engineering, only an hydraulic laboratory with its accessory tank room, a room provided with booths for surveying instruments, one class room and an office for the head of the department. This assignment was so manifestly disproportionate to the work done in the department that on moving into the new building the dean of engineering caused an apportionment to the department in all seventeen rooms, namely, those numbered, 3, 4, 5, 104, 105, 106, 107, 110, 111, 202, 203, 302, 304, 305, 306, 401 and 404. Not all of these have been occupied all of the year by classes, but they have all been needed at times, and some have been almost unavoidably crowded at intervals. Any considerable accession to the attendance in this department will call for undesirable limitations of sections, if not makeshifts, in order to avoid overcrowding.

I would call attention to the fact that student records at my office, statistics, correspondence and the preparation of aids to class work have increased the need of clerical assistance amazingly in the last two years, while there has been no corresponding provision of the necessary help. The result is deplorable, for our records are rapidly becoming less dependable. There is needed at least the services of a competent stenographer and clerk for half time throughout the college year. In my opinion, a more profitable arrangement would provide for the full time of a clerk who should have some knowledge of civil engineering.

To do full justice to the students who present themselves for instruction in civil engineering, it has become evident that there should be

secured some addition of high grade teaching ability in professional lines. There is needed most at the present time a capable man who has had practical experience in structural engineering and hydro-electric installation. Of course, all technical work were better taught if handled by men who have had considerable practice, but they must be good teachers as well as practitioners. With our present apportionment of funds and teachers, it is inevitable that a large part of our professional instruction must be directed by men who have themselves had but little practice outside of the schools of engineering. This statement is in no sense an invidious reflection upon the faithful and efficient efforts of those who have contributed to the success of this department. It is intended, among other things, to emphasize the fact that our provision of instrumental and material equipment has rather outrun the provision of capable teachers. Increasing liberality in the salaries of our instructors seems to promise better conditions in the future, and it is a pleasure to note that all instructors in civil engineering have renewed their contracts for the coming year.

Beginning with the fall of 1901, engineering students have been permitted to specialize in Civil Engineering, if they so desire. The first graduates who were permitted this option, completed their work in 1903. The number of graduates who have completed the Civil Engineering studies outlined above, to this time, is as follows: In 1903, 14; 1904, 5; 1905, 16; 1906, 25; 1907, 27; 1908, 30; total 117. During the period covered, there have been graduated 232 students in engineering; hence, it follows that 50% of the engineering graduates have had their major work in civil engineering.

At the time the Civil Engineering option was established, I predicted that one-fourth of our candidates for engineering degrees would desire the special training afforded by a series of civil engineering subjects.

In accordance with our custom, there has been prepared a table showing the work carried by this department during the year. This will answer questions of location, kind of work, and the like, which may be asked concerning the year's activities.

Class work of the department of mathematics and civil engineering for the year 1907-1908.

Class.	Subject.	Number of course.	Teacher.	Classroom.	Hour of meeting.	No. hours per week.	No. of students in class.
Fall term.							
Sub-freshmen	M. algebra	Math. 1c	Mr. Cornell	302 Eng Bldg	8-9	5	31
Sub-freshmen	M. algebra	Math. 1c	Mr. Cornell	302 Eng. Bldg	9-10	5	23
Sub-freshmen	M. algebra	Math. 1c	Mr. McVey	Abbot Hall	9-10	5	24
Sub-freshmen	M. algebra	Math. 1c	Mr. Heinrich	203 Eng. Bldg	2-3	5	26
Sub-freshmen	Ag. & W. algeb	Math. 1	Mr. Heinrich	203 Eng. Bldg	1-2	5	27
Sub-freshmen	Ag. & W. algeb	Math. 1	Mr. James	Abbot Hall	2-3	5	35
Sub-freshmen	Ag. & W. algeb	Math. 1	Dr. Gunderson	109 Eng. Bldg	2-3	5	28
Freshmen	M. algebra	Math. 1e	Dr. Gunderson	203 Eng. Bldg	9-10	5	16
Freshmen	M. algebra	Math. 1e	Mr. James	Abbot Hall	10-11	5	34
Freshmen	M. algebra	Math. 1e	Prof. Babcock	2 Col. Hall	10-11	5	36
Freshmen	M. algebra	Math. 1e	Prof. Babcock	2 Col. Hall	1-2	5	19
Freshmen	M. algebra	Math. 1e	Mr. Pierce	2 Col. Hall	2-3	5	29
Freshmen	M. algebra	Math. 1e	Mr. Jones	8 Col. Hall	2-3	5	27
Freshmen	Ag. & W. algebra	Math. 1b	Mr. Heinrich	12 Col. Hall	8-9	5	22
Freshmen	Ag. & W. algebra	Math. 1b	Mr. Jones	8 Col. Hall	9-10	5	21
Freshmen	Ag. & W. algebra	Math. 1b	Mr. Wendt	203 Eng. Bldg	10-11	5	30
Freshmen	Ag. & W. algebra	Math. 1b	Mr. Jones	8 Col. Hall	10-11	5	33
Freshmen	Ag. & W. algebra	Math. 1b	Mr. Pierce	301 Eng. Bldg	10-11	5	33
Freshmen	M. geom	Math. 2d	Mr. McVey	Abbot Hall	8-9	5	14
Freshmen	M. geom	Math. 2d	Mr. Heinrich	301 Eng. Bldg	11-12	5	25
Freshmen	M. geom	Math. 2d	Mr. Pierce	8 Col. Hall	11-12	5	24
Freshmen	M. geom	Math. 2d	Mr. James	Abbot Hall	11-12	5	17
Freshmen	M. geom	Math. 2d	Mr. Pierce	302 Eng. Bldg	1-2	5	25
Freshmen	M. geom	Math. 2d	Mr. James	Abbot Hall	1-2	5	30
Freshmen	M. geom	Math. 2d	Mr. Jones	8 Col. Hall	1-2	5	20
Sophomore	Anal. geom	Math. 5	Prof. Babcock	2 Col. Hall	8-9	5	35
Sophomore	Anal. geom	Math. 5	Dr. Gunderson	302 Eng. Bldg	10-11	5	28
Sophomore	Anal. geom	Math. 5	Dr. Gunderson	302 Eng. Bldg	11-12	5	35
Junior	Mech. of Eng	Math. 7a	Prof. Babcock	2 Col. Hall	11-12	5	17
Junior	Mech. of Eng	Math. 7a	Mr. Hadden	11 Eng. Bldg	11-12	5	17
Junior	Mech. of Eng	Math. 7a	Mr. Wendt	203 Eng. Bldg	11-12	5	18
Junior	Surveying (C)	C. E. 1b	Mr. Cornell	109 Eng. Bldg	11-12	2	36
Junior	Surveying (C)	C. E. 1b	Mr. McVey	11 Eng. Bldg	10-11	2	37
Junior	Surveying (Lab)	C. E. 1b	Mr. Cornell Mr. Wendt	111 Eng. Bldg	1-3	2	70
Junior	Surveying (Lab)	C. E. 1b	Mr. Wendt Mr. Cornell	111 Eng. Bldg	1-3	2	70
Junior	Surveying (Lab)	C. E. 1b	Mr. Wendt Mr. Cornell	111 Eng. Bldg	1-3	2	70
Senior	Ag. C. E. (C)	C. E. 2	Prof. Vedder Mr. Wendt	106 Eng. Bldg	8-10	4	18
Senior	Ag. C. E. (C)	C. E. 2	Prof. Vedder	109 Eng. Bldg	11-12	3	18
Senior	Graphics	C. E. 4	Mr. Wendt	11 Eng. Bldg	8-9	3	23
Senior	Graphics	C. E. 4	Prof. Vedder	111 Eng. Bldg	9-10	3	23
Senior	Bridge Str	C. E. 8a	Prof. Vedder	111 Eng. Bldg	10-11	3	15
Senior	Bridge Str	C. E. 8a	Mr. Hadden	109 Eng. Bldg	10-11	3	16
Senior	R. R. survey	C. E. 7	Mr. Hadden Mr. McVey	111 Eng. Bldg	1-4	6	30
Total	43 Sections					190	1,285

Class.	Subject.	Number of course.	Teacher.	Classroom.	Hour of meeting.	No. hours per week.	No. students in class.
Winter term.							
Sub-freshmen	Ag. & W. algebra	Math. 1a	Mr. Pierce	203 Eng. Bldg	9-10	5	15
Sub-freshmen	Ag. & W. algebra	Math. 1a	Mr. Cornell	302 Eng. Bldg	9–10	5	14
Sub-freshmen	Ag. & W. algebra	Math. 1a	Mr. Pierce	8 Col. Hall	2–3	5	24
Sub-freshmen	Ag. & W. algebra	Math. 1a	Mr. McVey	203 Eng. Bldg	3–4	5	30
Sub-freshmen	M. algebra	Math. 1d	Mr. Heinrich	8 Col. Hall	8–9	5	19
Sub-freshmen	M. algebra	Math. 1d	Mr. Heinrich	8 Col. Hall	9–10	5	24
Sub-freshmen	M. algebra	Math. 1d	Mr. Pierce	8 Col. Hall	1–2	5	22
Sub-freshmen	M. algebra	Math. 1d	Mr. Cornell	302 Eng. Bldg	1–2	5	25
Sub-freshmen	Plane geom	Math. 2	Mr. Cornell	302 Eng. Bldg	8–9	3	24
Sub-freshmen	Plane geom	Math. 2	Mr. McVey	Abbot Hall	9–10	3	24
Sub-freshmen	Plane geom	Math. 2	Mr. McVey	203 Eng. Bldg	2–3	3	24
Sub-freshmen	Plane geom	Math. 2	Mr. Cornell	302 Eng. Bldg	2–3	3	24
Freshmen	Ag. geom	Math. 2b	Mr. Jones	2 Col. Hall	8-9	5	24
Freshmen	Ag. geom	Math. 2b	Mr. James	Abbot Hall	10–11	5	14
Freshmen	Ag. geom	Math. 2b	Mr. Jones	111 Eng. Bldg	10-11	5	19
Freshmen	Ag. geom	Math 2b	Mr. James	Abbot Hall	11–12	5	19
Freshmen	Ag. geom	Math. 2b	Mr. McVey	203 Eng. Bldg	11–12	5	21
Freshmen	Ag. geom	Math. 2b	Prof. Babcock	2 Col. Hall	3–4	5	20
Freshmen	M. algebra	Math. 1f	Mr. James	Abbot Hall	8-9	5	19
Freshmen	M. algebra	Math. 1f	Dr. Gunderson	302 Eng. Bldg	10-11	5	21
Freshmen	M. algebra	Math. 1f	Mr. Pierce	203 Eng. Bldg	10–11	5	19
Freshmen	M. algebra	Math. 1f	Mr. James	Abbot Hall	1–2	5	24
Freshmen	M. algebra	Math. 1f	Mr. McVey	203 Eng. Bldg	1–2	5	25
Freshmen	M. algebra	Math. 1f	Mr. Jones	2 Col. Hall	2–3	5	23
Freshmen	M. algebra	Math. 1f	Mr. Cornell	302 Eng. Bldg	3–4	5	24
Sophomore	M. & W. Dif. Cal	Math. 6a	Prof. Babcock	2 Col. Hall	9–10	5	20
Sophomore	M. & W. Dif. Cal	Math. 6a	Dr. Gunderson	302 Eng. Bldg	11–12	5	26
Sophomore	M. & W. Dif. Cal	Math. 6a	Mr. Jones	2 Col. Hall	1–2	5	18
Sophomore	M. & W. Dif. Cal	Math. 6a	Dr. Gunderson	111 Eng. Bldg	1–2	5	19
Junior	Mechanics	Math. 7b	Mr. Wendt	203 Eng. Bldg	8–9	5	22
Junior	Mechanics	Math. 7b	Prof. Babcock	2 Col. Hall	10-11	5	14
Junior	Mechanics	Math. 7b	Prof. Babcock	2 Col. Hall	11–12	5	16
Senior	Ag. Eng	C. E. 3	Prof. Vedder	106 Eng. Bldg	8–9	5	16
Senior	Bridge Des'n	C. E. 8b	Prof. Vedder	304 Eng. Bldg	9–11	8	14
Senior	Bridge Des'n	C. E. 8b	Mr. Hadden	304 Eng. Bldg	9–11	8	14
Senior	Hydraulics (C)	C. E. 5	Mr. Hadden	111 Eng. Bldg	11–12	5	19
Senior	Hydraulics (C)	C. E. 5	Mr. Wendt	109 Eng. Bldg	11–12	5	19
Senior	Hydraulics (L)	C. E. 5	Mr. Wendt	306 Eng. Bldg	1–5	4	11
Senior	Hydraulics (L)	C. E. 5	Mr. Wendt Mr. Hadden	306 Eng Bldg	1–5	4	19
Senior	Hydraulics	C E. 5	Mr. Hadden	304 Eng. Bldg	1–5	4	11
Senior	Exp. Lab	C. E. 12	Mr. Wendt	111 Eng. Bldg	1–5	8	14
Senior	Exp. Lab	C. E. 12	Mr. Heinrich	111 Eng. Bldg	1–5	8	14
Senior	Water Supply	C. E. 15	Mr. Hadden	111 Eng. Bldg	8–9	3	15
Senior	Astronomy	C. E. 14	Dr. Gunderson	111 Eng. Bldg	8–9	2	14
Senior	Astronomy	C. E. 16	Dr Gunderson	111 Eng Bldg	9–10	5	14
Totals	45 Sections					113	880

Class.	Subject.	Number of course.	Teacher.	Classroom.	Hour of meeting.	No. hours per week.	No. students in class.
Spring term.							
Sub-freshmen....	Ag. & W. geom........	Math 2a...	Mr. Pierce..............	8 Col. Hall......	10-11	5	17
Sub-freshmen....	Ag. & W. geom........	Math. 2a....	Mr. Pierce..............	8 Col. Hall......	10-11	5	17
Sub-freshmen....	Ag. & W. geom........	Math. 2a....	Dr. Gunderson..........	302 Eng. Bldg...	1-2	5	21
Sub-freshmen....	Ag. & W. geom........	Math. 2a....	Mr. Wendt..............	203 Eng. Bldg..	2-3	5	26
Sub-freshmen....	M. geom..............	Math. 2c....	Mr. Heinrich...........	203 Eng. Bldg...	9-10	5	17
Sub-freshmen....	M. geom..............	Math 2c....	Mr. Heinrich...........	11 Eng. Bldg....	11-12	5	18
Sub-freshmen....	M. geom..............	Math. 2c....	Mr. Pierce..............	8 Col. Hall......	1-2	5	18
Sub-freshmen....	M. geom..............	Math. 2c....	Mr. Pierce..............	8 Col. Hall......	2-3	5	14
Sub-freshmen....	Mensuration...........	Math. 3.....	Mr. Cornell..............	302 Eng. Bldg...	8-9	5	21
Sub-freshmen....	Mensuration...........	Math. 3.....	Mr. McVey..............	203 Eng. Bldg...	11-12	5	16
Sub-freshmen ...	Mensuration...........	Math. 3.....	Mr. James..............	2 Col. Hall......	1-2	5	25
Sub-freshmen....	Mensuration...........	Math. 3.....	Mr. James..............	2 Col. Hall......	2-3	5	19
Freshmen.......	Ag. & W. Trig.........	Math. 4a....	Mr McVey..............	111 Eng. Bldg...	8-9	3	15
Freshmen.......	Ag. & W. Trig.........	Math. 4a....	Mr. James..............	12 Col. Hall.....	8-9	3	21
Freshmen.......	Ag. & W. Trig.........	Math. 4a....	Prof. Babcock...........	302 Eng. Bldg...	2-3	3	20
Freshmen.......	Ag. & W. Trig.........	Math 4a....	Mr. Cornell..............	111 Eng. Bldg...	2-3	3	18
Freshmen.......	M. Trig...............	Math. 4b....	Mr. Heinrich...........	203 Eng. Bldg...	8-9	5	13
Freshmen.......	M. Trig...............	Math. 4b...	Mr. Cornell..............	302 Eng. Bldg...	8-9	5	12
Freshmen.......	M. Trig...............	Math. 4b...	Mr. McVey..............	203 Eng Bldg...	10-11	5	24
Freshmen.......	M. Trig...............	Math. 4b...	Mr. James..............	2 Col. Hall......	11-12	5	29
Freshmen.......	M. Trig...............	Math. 4b...	Mr. Jones..............	Abbot Hall......	1-2	5	21
Freshmen.......	M. Trig...............	Math. 4b...	Mr. Jones..............	Abbot Hall......	2-3	5	20
Freshmen.......	M. Trig...............	Math. 4b...	Mr. Jones..............	Abbot Hall......	3-4	5	18
Sophomore......	Integ. Cal............	Math. 6b...	Dr. Gunderson..........	8 Col. Hall......	8-9	5	16
Sophomore......	Integ. Cal............	Math. 6b...	Mr. Jones..............	Abbot Hall......	8-9	5	19
Sophomore......	Integ. Cal............	Math. 6b...	Prof. Babcock...........	2 Col. Hall......	9-10	5	18
Sophomore......	Integ. Cal............	Math. 6b...	Prof. Babcock...........	2 Col. Hall......	10-11	5	15
Sophomore......	Integ. Cal............	Math. 6b...	Dr. Gunderson..........	302 Eng. Bldg...	11-12	5	17
Junior..........	Str. of Mat...........	Math. 7c....	Mr. Polson..............	109 Eng. Bldg...	8-9	5	16
Junior..........	Str. of Mat...........	Math. 7c....	Prof. Babcock...........	2 Col. Hall......	8-9	5	16
Junior..........	Str. of Mat...........	Math. 7c....	Mr. Wendt..............	203 Eng. Bldg...	1-2	5	18
Junior..........	H. Surveying (C)......	C. E. 6.....	Prof. Vedder......... Mr. Cornell...........	111 Eng. Bldg...	10-11	3	45
Junior..........	H. Surveying (F)......	C. E. 6.....	Mr. McVey........... Mr. Heinrich......... Mr. Cornell...........	106 Eng Bldg...	1-4	6	45
Junior..........	Astronomy............	C. E. 14....	Dr. Gunderson..........	111 Eng. Bldg...	9-10	5	14
Junior..........	Astronomy............	C. E. 14....	Dr. Gunderson..........	302 Eng. Bldg...	10-11	3	23
Senior..........	H. Surveying (C)......	C. E 6.....	Prof. Vedder......... Mr. Cornell...........	111 Eng. Bldg...	10-11	3	12
Senior..........	H. Surveying (F)......	C. E. 6.....	Mr. McVey........... Mr. Heinrich......... Mr. Cornell...........	107 Eng. Bldg...	1-4	6	12
Senior..........	Masonry and arches....	C. E. 9.....	Mr. Hadden..............	306 Eng. Bldg...	8-11	8	12
Senior..........	Masonry and arches....	C. E. 9.....	Mr. Wendt..............	304 Eng. Bldg...	8-11	8	14
Senior..........	Thesis	C. E. 11....	Prof. Vedder......... Mr. Hadden..........	106 Eng. Bldg...	1-5	12	29
Senior..........	Contracts & specifications................	C. E. 13....	Prof. Vedder............	11 Eng. Bldg....	9-10	2	27
Senior..........	Pavements............	C. E. 10....	Prof. Vedder............	111 Eng. Bldg...	10-11	2	27
Special..........	....	C. E. 1a....	Mr. McVey..............	111 Eng. Bldg...	8-9	2	13
Special..........	....	C. E. 1a....	Mr. Hadden..............	203 Eng. Bldg...	3-5	2	13
Totals......	42 Sections...........	....	....	....	....	74	854

The following text books have been used in our classes during the year: Allen's Railroad Curves and Earthwork; Merriman & Jacoby's Roofs; Bridge Design Vols. I, II and III; Hodgman's Land Surveying and Vedder's Notes on Surveying; Church's Mechanics; Tanner & Allen's Analytic Geometry; Beeman & Smith's Academic Algebra for all beginning classes formed by women and agricultural students; Well's

Text Book in Algebra for engineering students; Wentworth's Geometry; Todd's New Astronomy for engineers; Young's Elements of Astronomy for women; Murray's Differential Calculus; Ashton & Marsh's Trigonometry; Beeman & Smith's Higher Arithmetic; Baker's Roads and Pavements; Baker's Masonry Construction; Turneaure & Russell's Public Water Supplies; Folwell's Sewerage.

The inventory of the department aggregated $13,412.06 as compared with $7,906.21 in 1906.

The total expenditure by the department during the year for all purposes has been $6,748.90, of which $133 was turned in for special examinations.

Respectfully submitted,
H. K. VEDDER,
Professor of Mathematics and Civil Engineering.

East Lansing, Mich., June 30, 1908.

REPORT OF THE DEPARTMENT OF PHYSICS AND ELECTRICAL ENGINEERING.

President J. L. Snyder:

Dear Sir:—Since my last report the department has moved into their new quarters, using the basement, first and second floors of the west half of the engineering building. We have had a very strenuous year, as the building was not ready for us to move in before the beginning of school, hence our apparatus was not completed until after the beginning of school, which made quite a little confusion. However we have been able to put the work on a very different basis than heretofore, on account of the increased accommodations.

Instead of one laboratory for all of the work in physics we now have four good sized rooms in which to do all of the laboratory work of the different classes. Instead of one lecture room we now have a larger lecture room, seating 128 students, and an auxiliary lecture room which will hold forty students, and a quiz room.

We have enrolled 802 students this year, which is considerable more than any previous year.

Due to changes, we have not had as many students this year as we shall have next year. The physics work of the engineering students has been changed from the freshmen to the sophomore year. A course in photography has been authorized by the faculty, and next year we shall have that class to handle as well, so that we shall soon be taxing our capacity, if the present increase is kept up.

Last summer Mr. Curtis resigned, and there has been in the department since, Mr. W. L. Lodge, Mr. C. W. Chapman, and Mr. W. H. Wadleigh, for the work in Physics, and E. N. Bates, in the electrical engineering, besides myself.

Below is given in tabular form, an outline of the classes carried on this year.

Sub-Freshmen.

	Fall.	Winter.	Spring.
Women		4 hrs. recit 2 hrs. lab	4 hrs. recit. 2 hrs. lab.
Engineering	3 hrs	1 hr. recit 2 hrs. lab	3 hrs. recit. 2 hrs. lab.
Agriculturals		4 hrs. recit 2 hrs. lab	4 hrs. recit. 2 hrs. lab.

Freshmen.

	Fall.	Winter.	Spring.
Women			2 hrs. recit. 2 hrs. lab.
Agriculturals			2 hrs. recit. 2 hrs. lab.

Sophomores.

	Fall.	Winter.	Spring.
Women	3 hrs. recit. 4 hrs. lab.		
Engineering	4 hrs. recit 2 hrs. lab	4 hrs. recit 2 hrs. lab	4 hrs. recit. 2 hrs. lab.
Agricultural	4 hrs. recit 2 hrs. lab	4 hrs. recit 2 hrs. lab	

A course in electrical engineering has been started this year. The first class, juniors, have completed one year's work. Next year and hereafter we will have a Junior and Senior class in electrical engineering. Below is an outline of the work in electrical engineering this year:

Juniors.

Fall.	Winter.	Spring.
Elec. Eng. 4a 1 hr. recit 2 hrs. lab	Elec. Eng. 4b 1 hr. recit 2 hrs. lab	
Elec. Eng. 1a 1 hr. recit 4 hrs. drawing	Elec. Eng. 1b 3 hrs. recit	Elec. Eng. 4 hrs. recit. 3 hrs. lab.

Seniors.

Fall.	Winter.	Spring.
Elec. Eng 3 hrs. recit 3 hrs. lab	Elec. Eng 5 hrs. recit 4 hrs. lab	

In the senior class mentioned there are some mechanical engineering students who elected to take some work in electrical engineering. During the year considerable additional apparatus has been purchased and our inventory this year amounts to $17,601.70.

Very respectfully,

A. R. SAWYER,

Professor of Physics and Electrical Engineering.

East Lansing, June 30, 1908.

REPORT OF THE DEPARTMENT OF DRAWING AND DESIGN.

To the President:

It becomes my painful duty to report to you the death of Professor William Saunders Holdsworth on September 18th at his home near the campus. As probably other notice of his work at M. A. C. will be given elsewhere, I will simply say that his death closed a continuous service of about twenty years in this department, and that I personally felt his loss very keenly, as we had been associated for ten years.

The Board of Agriculture, at their meeting late in September, placed the department in my hands for the school year and at the same time raised me to the rank of assistant professor. I wish at this time to express my personal appreciation for this recognition of my past services. I would also mention especially the very courteous treatment I received throughout the year at the hands of Dean Bissell and President Snyder. In regard to the details of the department work of the year, I very respectfully report as follows: Instructor Frank M. Gracey resigned to go to the Massachusetts Agricultural College in September. On September 1st, Mr. Charles H. Harper and Mr. William H. Perkins were engaged as instructors for the year. Mr. Harper is a graduate of the Mechanical Engineering department of the Maryland Agricultural College with a degree of B. S. Mr. Harper has also acted as tutor and has other valuable training in practical engineering work previous to coming here. Mr. Harper gave us more than ordinary satisfaction as an instructor and he took an intimate interest in the details of the department work and college affairs in general, which I consider highly commendable. Mr. Perkins came here from Massachusetts and is a graduate of the Rindge Manual Training School of Cambridge. He had also taken some work at the Massachusetts Institute of Technology and had been employed two years in architectual offices at drafting. He was enthusiastic in his work here and he hopes to continue studies in engineering this year. He will not return next September.

Upon completion of the enrollment about October 1st, it was found necessary to engage the following additional help: Mr. Charles C. Cobb, a junior engineer in this college, and a practical sheet metal worker; Mr. Fritz G. Cornell, a forestry sophomore, who entered M. A. C. with some advanced standings and who is a graduate of the Louisville, Kentucky, Manual Training High School, and who has taught two and one-half years in manual training schools in the South; and Miss Florence Rounds, a graduate of the Home Economics course of this college of 1907.

Mr. Cobb and Mr. Cornell gave instruction by the hour, principally in the engineering drawing classes and their work was highly satisfactory to me.

Miss Rounds gave instruction in free hand drawing by the hour and her work was also to be commended.

We have very much appreciated our new quarters in the Engineer-

ing Hall and have been enabled, from funds allowed, to place the equipment for handling several hundred students each term. The tables accompanying this report will show a large increase in student attendance in our department over last year. As in past years, I have engrossed the diplomas of the graduating class. Additional details of the work of the instructors is given in the following table:

Fall term drawing classes—1907.

Class.	Subject.	Instructor.	Section.	Hours.	Students in class.
Sub-Fresh. W	1 F. H. Drawing	Miss Holt	I	2	31
Sub-Fresh. Ag	1 F. H. Drawing	Miss Holt	I	2	26
Sub-Fresh. Ag	1 F. H. Drawing	Mr. Cobb	II	2	26
Sub-Fresh. Eng	4a–4c F. H. & Mech	Mr. Harper	I	6	20
Sub-Fresh. Eng	4a–4c F. H. & Mech	Mr. Cornell	II	6	22
Sub-Fresh. Eng	4a–4c F. H. & Mech	Mr. Cobb	III	6	26
Sub-Fresh. Eng	4a–4c F. H. & Mech	Mr. Perkins	IV	6	29
Freshman Ag	1c F. H. Drawing	Mr. Cobb	I	4	31
Freshman Ag	1c F. H. Drawing	Mr. Perkins	II	4	38
Freshman W	1b F. H. Drawing	Miss Holt and Miss Rounds	I	6	44
Freshman Eng	4a & 4b F. H. & Mech	Mr. Harper	I	6	30
Freshman Eng	4a & 4b F. H. & Mech	Mr. Perkins	II	6	27
Freshman Eng	4a & 4b F. H. & Mech	Mr. Perkins	III	6	26
Freshman Eng	4a & 4b F. H. & Mech	Mr. Harper	IV	6	24
Sophomore Eng	5b Desc. Geometry	Prof. Newman	I	5	32
Sophomore Eng	5b Desc. Geometry	Prof. Newman	II	5	31
Sophomore Eng	5b Desc. Geometry	Prof. Newman	III	5	26
Sophomore W	1e Charcoal	Miss Holt	I	5	18
Junior Eng	6 Topographical	Mr. Harper	I	6	35
Totals			19	94	542

Instructors, full time (4); part time (3).

Winter term drawing classes—1908.

Class.	Subject.	Instructor.	Section.	Hours.	Students in class.
Sub-Fresh. Ag	1a F. H. Drawing	Miss Rounds	I	2	20
Sub-Fresh. Ag	1a F. H. Drawing	Prof. Newman	II	2	29
Sub-Fresh. W	1a F. H. Drawing	Miss Rounds	I	2	30
Sub-Fresh. Eng	4d Mech. Drawing	Mr. Perkins	I	8	16
Sub-Fresh. Eng	4d Mech. Drawing	Mr. Perkins	II	8	21
Sub-Fresh. Eng	4d Mech. Drawing	Mr. Harper	III	8	28
Sub-Fresh. Eng	4d Mech. Drawing	Mr. Cobb	IV	8	20
Fresh. W	1d Charcoal	Miss Holt	I	4	28
Fresh. W	1d Charcoal	Miss Rounds	II	4	30
4-yr. Fresh. Eng	4e Mech & Mach	Mr. Cobb	I	10	21
4 yr. Fresh. Eng	4e Mech. & Mach	Mr. Cornell	II	10	23
4-yr. Fresh. Eng	4e Mech. & Mach	Prof. Newman	III	10	30
4-yr. Fresh. Eng	4e Mech. & Mach	Mr. Harper	IV	10	26
5-yr. Fresh. Eng	4f Mach. Draw	Prof. Newman	I	6	22
5-yr. Fresh. Eng	4f Mach. Draw	Mr. Harper	II	6	26
Sophomore W	1d Charcoal	Miss Holt	I	4	21
Junior W	2b History Art	Miss Holt	I	5	13
Junior-Civ. Eng	7 Shades, Shad. & Persp.	Mr. Perkins	I	8	35
Sophomore Eng	5b Desc. Geom	Prof. Newman	Special	....	5
Totals			18	115	445

Instructors, full time (4); part time (3)

Spring term drawing classes—1908.

Class.	Subject.	Instructor.	Section.	Hours.	Students in class.
Sub-Fresh. Eng.	4f Mach. Draw	Mr. Harper	I	6	19
Sub-Fresh. Eng.	4f Mach. Draw	Mr. Cornell	II	6	21
Sub-Fresh. Eng.	4f Mach. Draw	Prof. Newman and Mr. Perkins	III-IV	6	34
4-yr. Fresh. Eng.	5a Desc. Geom	Prof. Newman	I	6	21
4-yr. Fresh. Eng.	5a Desc. Geom	Mr. Perkins	II	6	26
4-yr. Fresh. Eng.	5a Desc. Geom	Prof. Newman	III	6	29
4-yr. Fresh. Eng.	5a Desc. Geom	Mr. Perkins	IV	6	30
5-yr. Fresh. Eng.	5a Desc. Geom	Mr. Harper	I	6	27
5-yr. Fresh. Eng.	5a Desc. Geom	Mr. Perkins	II	6	20
Sophomore W	Mech. Drawing	Miss Holt	I	4	33
Senior F	Topographical	Mr. Harper	I	10	4
	Special	Prof. Newman			4
Totals			11	68	258

Instructors, full time (4); part time (1).

Respectfully submitted,
CHACE NEWMAN,
Assistant Professor of Drawing.

East Lansing, June 30, 1908.

REPORT OF THE WOMEN'S DEPARTMENT.

To the President:

Dear Sir:—The enrollment in the Women's Department the past year was two hundred, sixty of whom were specials. The building was crowded during the fall and winter terms, but several of the rooms were free for the use of guests in the spring. It becomes more and more evident each year that we are in need of a students' aid fund. A small sum, even, could be used to advantage for students who are paying their own way, and who must drop out before the end of the year.

We began the year with a new teacher, Miss Pearl MacDonald, in charge of Domestic Science, and the dining room. Miss MacDonald has given much attention to club matters, and succeeded in having good meals served at an average of $2.15 per week. Miss Bemis has given very successfully some of the courses heretofore taken by the senior teacher, thus securing for Miss MacDonald more time for club duties. In the fall and winter, Miss Lillian Taft rendered valuable assistance by taking one of the sections in first year cookery.

The department regretted very much to lose Mrs. Haner, who left us in February to accept a position in the University of Idaho. She had been in charge of the work in Domestic Art, since the department was organized, and her faithful services, and careful work were always

appreciated. The assistant Miss Florence Mundon, continued in charge of first year sewing, and helped to bridge over the gap until Mrs. Haner's successor could be initiated. Mrs. F. Leona Gaskins, one of our former students, very kindly came to our relief, and took charge of the work for the remainder of the year. Her Normal Training class was particularly successful. The small girls from the village school were invited to come to the sewing rooms one afternoon in the week, when the senior women, under the direction of Mrs. Gaskins, gave instruction in plain sewing.

The work in music and physical training under Miss Freyhofer and Miss Chapman respectively, has been carried on as usual with earnestness and good results. We regret that Miss Thorburn, because of continued ill health, was not able to remain with us. Miss Hopson will assist Miss Freyhofer next year, as she has done the past term, with the extra music pupils, and as chorus and choir accompanist.

The large number of irregular students in our department, non-candidates for a degree, shows a demand for a special course for women. In my report two years ago, the suggestion was made that a two years' course in Home Economics should be offered for this class of students. The need and opportunity are more evident at the present time.

The regular Home Economics course as now outlined, will no doubt be subject to modification. The work of the sophomore year has not yet been put into effect, and we hope that certain changes in it may be made early in the coming year.

Respectfully submitted,
MAUDE GILCHRIST,
Dean of the Women's Department.

East Lansing, June 30, 1908.

REPORT OF THE DEPARTMENT OF CHEMISTRY.

Mr. J. L. Snyder, President, M. A. C.:

Dear Sir:—A review of the year's work shows that the department has had the largest number of students in its history at work in the laboratory. The following summary gives the number of students receiving instruction each day in the laboratory during each term of the year.

Fall Term.	Number of students.
General Chemistry:	
Agricultural	103
Mechanical	163
Organic Chemistry:	
Agricultural	58
Women	27
Total	351

Winter Term.	Number of students.
Mineralogy	148
Qual. Anal. men	91
Special Short Course Chemistry	77
Dairy Chemistry	11
Beet Sugar Technology	6
Agriculture, 9b (Special work)	2
Total	335

Spring Term.	Number of students.
Engineering Chemistry	138
Quant. Anal	6
Domestic Science Chemistry	12
Animal Nutrition (Ag. 5a.)	9
Total	155

Amount received from the above students in laboratory fees, $2,247.00.

This work has been accomplished with a minimum expenditure of effort on account of the additional space afforded this department by the removal of the physical department from the chemical laboratory to the new engineering building. In the basement at the north end of the building formerly occupied by the physical department for laboratory work and divided up into several rooms we have now one large well lighted room which has been especially fitted for work in mineralogy and also affords us additional space for general laboratory work. Above this is the "original lecture room" which has been refitted with new seats and affords an excellent lecture room for the courses in organic chemistry. Adjacent to this is the office and work room of Assistant Professor Reed. A portion of the space formerly used by the physical department as a private laboratory on this floor has been connected with the analytical room giving us a small but very convenient balance room for beginning work. Above this is a sky-light which assists very materially in the ventilation both of the balance room and the connecting laboratory. These improvements were authorized by the Board in July, 1907, and were completed just in time to be available at the opening of the year's work.

The assay material and furnaces for fire assay were early this spring removed to an outhouse some distance south of Wells Hall which has been fitted up and made into a very convenient room for fire assay work. We have now two Cupel and one Crucible furnace mounted so as to be ready for work at any time. Removing this material from the chemical laboratory and establishing it by itself makes the danger from fire in the laboratory very much less and is a decided improvement. This additional space enables us to teach the elements of fire assay

work to a class of 138 students divided into divisions of fourteen working at a time.

The year's work taken as a whole I consider to be fully as successful as any which the department has enjoyed since its establishment. I wish to thank you and the Board of Agriculture for their hearty co-operation.

Not much time nor opportunity has been afforded for either myself or my co-laborers doing work outside of the department, however, Instructor Clark has succeeded in developing with the students the best military band that the college has ever had, this without in any way interfering with his duties as instructor in the chemical department.

The special course lectures in simple elementary chemistry given to the short course students during January and February prevented me from doing any work in the Farmer's Institutes during the past winter. The usual amount of routine analytical work for various citizens of the state on investigations of soils, fertilizers, insecticides, feeding stuffs, minerals and various commercial products has been done.

I wish to acknowledge the very efficient assistance of the entire force which during the year has been as follows:

Instructors: H. S. Reed, Assistant Professor; J. F. Darling; R. R. Tower, took the place of Mr. Boyles from Nov. 15th to Jan. 1st; A. J. Clark; F. M. Boyles, resigned Nov. 15th to accept position with the government; E. A. Goodhue, clerk and stenographer; George Churchill, caretaker.

Respectfully submitted,
FRANK S. KEDZIE,
Professor of Chemistry.

East Lansing, June 30, 1908.

REPORT OF THE DEPARTMENT OF HISTORY AND ECONOMICS.

To the President:

I have the honor of submitting the following report concerning the department of History and Economics for the year 1907-8.

The total number of enrollments in this department during the year was 1,129, distributed as follows:

By Terms: Autumn, 302; winter, 439; spring, 388.

By Classes: Sub-Freshmen, 161; freshmen, 415; sophomores, 148; juniors, 209; seniors, 123; specials, 63.

By Subjects: History, 622; economics, 372; "education," 79; political science, 63.

The total number of hours taught during the year was 1,776, divided among the three terms as follows:

Autumn, 408; winter, 684; spring, 684.

By subjects the number of recitation hours during the year equalled in history, 1,044; in economics, 442; in "education," 180, and in political science, 120.

The number of subjects offered by this department is approximately

twenty-five, but the actual number of classes taught is in excess of this since frequently a subject is given to more than one division of students.

The size of the recitation division has ranged uniformly large, since an inspection of the class rolls of the thirty-three recitation classes conducted by members of the department during the year shows that in nineteen there were more than thirty students while in only seven rolls were there less than twenty-five students. The average number in attendance at classes was thirty-three students per class.

As is well known, the apportionment of students to recitation classes in the different collegiate courses contemplates a much smaller number than the average just shown. It is possibly due to the fact that special students are so easily classified into subjects like history and economics that the class enrollments in these studies are abnormally large.

The momentous alterations which the curriculum of each of the college "courses" has sustained during the past year suggests the expediency of showing here, the participation, under the new arrangement, of this department in the work of the college. The representation is tabulated as follows:

Name of Course.	Number of Subjects offered.	Economics.	History.	Political Science.	Education.	Required.	Elective.
Agricultural	10	Commercial Geography. Industrial History. Economic Principles. Economic Problems. Finance. Sociology.	English, European, United States Constitutional.	Civil Government of United States.		Three	Six
Engineering.	5	Economic Principles. Economic Problems.	English. European.	Civil Government of United States.			Five
Women's.	12	Commercial Geography. Economic Principles. Economic Problems. Finance. Sociology.	English, Early European. Later European. Constitution of United States.		Psychology, Principles of Pedagogy. History of Education.	Four.	Eight
Forestry.	9	Same as Agriculturals.	English. European.	Same as Agriculturals.		Three.	Five.

The great excess of "electives" over required subjects which this tabulation shows is a situation which has been consistently characteristic of this department. It is a condition which has proven no drawback to the department, and indeed may be regarded as a positive benefit since the customary stimulus toward improvement which is given by rivalry among competitors is not without application to teachers.

It is scarcely necessary to say that demands upon a department which has become so largely increased—amounting to a doubling of the enrollments over any previous year and to an enlargement by a half of the number of hours taught—could not be met without addition to the teaching force. Fortunately the services of Mrs. Minnie Hendrick were again available, and she assumed the position of instructor in history at the beginning of the year. At the commencement of the winter

term Mr. Carl McAlvay was employed to instruct the classes which were still in excess of the number which three teachers could find time to meet. Mr. McAlvay is a graduate from the State University, has had much experience as a teacher, and extreme good luck enabled this department to secure his assistance. He was entitled by the State Board, Instructor in History and Economics.

The competency of the department to meet its purposes has been increased in every way by the assignment to it this year of permanent class rooms, and of adequate office accommodations. At the beginning of the year the withdrawal of certain engineering departments from College Hall left vacant the large class room at the south end of this building with the connected suite of offices and a class room upon the third floor. These were assigned to this department and were promptly occupied. The loss of time through having to hunt for class rooms at the beginning of each term, as well as the waste of going frequently to distant buildings to hold classes and the unnecessary wear and tear upon departmental accessories, maps, reference books, etc., are now all obviated through having permanent and convenient class rooms. The gains to departmental efficiency, also through having suitable offices in which students may consult with their teachers at any time are benefits not easily over-estimated.

The science courses in this department have been voted recently by the faculty to be suitable subjects for "majors" to students needing post-graduate work. This action is especially timely since there seems to be a now well developed field of knowledge, adapted particularly to agricultural students comprised within what is known as Agricultural Economics. It is believed that advanced students might work very profitably in this new area of study and the hope is expressed here that opportunities in this sort of work may soon be offered by this college.

The members of the department have done their full duty, it is believed, toward the extra class room obligations such as attending teachers, faculty, and committee meetings, which constitute no small part of college management. The first assistant in the department, Mr. Ryder, has had a peculiarly arduous and responsible position as class officer for the freshmen and, during a part of the year, for the sub-freshmen classes. The large size of these classes as well as the constantly increasing amount of supervision which is expected from the class officer, makes the office one of no little care. Much time has been required from the head of the department too, through the administrative work required from him as chairman of the social committee. The supervision of the book store management also has taken time and given responsibility.

In reviewing the work of this very busy year for the department of History and Economics, I am urged again to express my appreciation of the faithfulness and ability with which my assistants, Mr. Ryder, Mrs. Hendrick, and Mr. McAlvay, have rendered every service which would minister properly to the students who have come under their care.

Very respectfully,

WILBUR O. HEDRICK,

Professor of History and Economics.

East Lansing, June 30, 1908.

REPORT OF THE DEPARTMENT OF ENGLISH AND MODERN LANGUAGES.

President J. L. Snyder, East Lansing, Michigan:

My Dear Sir:—During the college year just closed the work in this department has developed in various ways. The change in all the courses of study, although it has decreased the required amount of work in English and modern languages, has increased the amount required during the freshmen and sophomore years. This increase, together with the large number in the classes entering last fall, made necessary the securing of additional instructors in the department. During the fall term Mr. Frank G. Tompkins and Mr. Wm. A Robinson were secured to give their whole time to the teaching of English. Miss Helen Michaelides was added to the department, to her being entrusted the teaching of French. Mrs. Minnie Hendricks, an instructor in the history department, devoted part of her time to classes in English.

At the opening of the winter term Mrs. Hendricks was needed for full time in the history department. This fact, together with the very large increase in the number of students studying German, necessitated the hiring of Mr. J. C. Paltridge and Mr. Leslie N. Cullom, both of whom remained with the department throughout the rest of the year. The exigencies of the program made necessary more sections in the sub-freshmen, freshmen, and sophomore classes, with the result that the numbers in the various sections were somewhat less than last year. This made possible in the department more individual attention to students than has heretofore been given.

The endeavor has been to have all students who were somewhat slow in their work interview their respective instructors regularly. This attempt has not met with the response from the students which we desired, their time being so occupied that it is all but impossible for them to find opportunity to interview the instructors outside of class hours. Further, the traditions of the college have made this individual work with the students somewhat irksome to instructors, as in the past but little of it has been done, at least in this department. I sincerely hope that next year this work will be developed still further, as I feel that this personal touch between student and instructor is more vital than any other part of college training.

The completion of the Engineering Hall and the consequent removal from College Hall of the office of the department of mathematics, made possible an office for the instructors in this department, something which they had not previously had. Room No. 4 was set apart for this work. It has been supplied with desks, and continually during the year it has been in use by instructors in legitimate office work. Without the facilities thus afforded the individual work of which I have spoken would not have been possible. Both the instructors and the head of the department wish to express to the State Board of Agriculture their appreciation of the appropriation which made this possible.

During the fall term 1,028 students were registered in the study of

English, 73 in the study of German, and 33 in the study of French. During the winter term the numbers were as follows: English, 953; German, 193; and French, 23, and during the spring term the numbers were as follows: English, 742; German, 129; and French, 15. The total number in the fall term was 1,134, in the winter term 1,169 and in the spring term 886.

At the close of the year Mr. L. N. Cullom resigned his position to go into work of another nature. Mr. Frank G. Tompkins also resigned. He accepts a position in the English department of the State University. Mr. Tompkins came to us as a teacher of experience and as a man thoroughly acquainted with his subject and in love with his work. These qualities have made him one of the most valuable members of the department. It seems to me that the policy of the college should be to keep an instructor of this type, even in spite of the allurements of teaching in his alma mater, of being associated with one of the greatest universities in the land, and of receiving a decided increase in salary. This institution cannot afford to lose a man of this type, no matter how much salary it takes to keep him.

Mr. George L. Stevens, who has been in the department for three years, also resigned. He felt that it was unwise for him to risk further winters in the climate of Michigan. Of the value of his services to the department and to the college, too much cannot be said. No better teacher has ever been a member of the department. No instructor has had a more elevating and ennobling influence on the students who came under his charge. His affability and constant good cheer have been a marked characteristic of the social life of the younger people of the community. No other plea than that of health would persuade the department to permit him to leave. With him go the heartiest wishes of his unnumbered friends among the people of the community and among the students.

In my last report I recommended the introduction of language phones for the study of German. It has seemed impossible to introduce this aid to our work because of a lack of room to install them. I hope that the completion of the Agricultural building will render it possible for us to favor our students with this opportunity, if we find it impossible to do so at an earlier date. Something of the laboratory work suggested in my last report for work in English literature has been attempted. The results have been such as to assure me that it is advisable to introduce still more of this kind of work. As I said a year ago, however, such work is greatly hampered by the limitations of the library building.

The department has done away with the former custom of giving credit for work done in German in high school. Students who have had German are permitted to enter advanced classes, but are not given credit toward graduation for earlier work. Their graduation from high school was made possible by the credits received from this work. To use the same credits, a second time, toward graduation from college seems to me entirely unwarranted.

I am glad to report that the intercollegiate debate with Ypsilanti State Normal College, which for seven years has been under the general direction of this department, was won both last year and this year by this college. I wish to express my appreciation of the help given

in this work by the members of other departments in the college, and especially to thank the members of this year's debating team, Messrs. C. C. Taylor, H. L. Kempster, and O. J. Oviatt, for their constant, unceasing, and determined work which made victory possible. Messrs. Kempster and Taylor have the unique honor of having belonged to two winning teams, the teams which won the only series of debates which this college has been so fortunate as to secure. All of the members of this year's team are juniors in the Agricultural course.

During the year a term's work in dramatics has been offered for the first time, as an elective. This work calls for the public presentation of brief plays. It has proven popular, both to the students taking the course and as an amusement to the college community at large. The portable stage provided by the college for erection in the armory has made possible the presentation of these plays in an appropriate manner, with scenery, curtain, etc. For these requisites to the full usefulness of this course the department is grateful, while the frequent use made of the stage by various college organizations seems to warrant, from an entirely different point of view, the money expended for it and its appurtenances.

For the services of an office clerk during part of each day for the latter half of this year I wish to thank you and the members of the State Board.

I have only praise for the work of the other members of the department during the year. They have made the welfare of the department their ideal, and toward this ideal they have unceasingly striven. To those of the department who have helped me in the detail work of editing the volume of the proceedings of the semi-centennial celebration, I wish to express special thanks, as the work in no way legitimately belonged to them.

Yours most respectfully,
THOS. C. BLAISDELL,
Professor of English and Modern Languages.

East Lansing, June 30, 1908.

REPORT OF THE DEPARTMENT OF ZOOLOGY AND PHYSIOLOGY.

To the President:

Sir:—I have the honor to submit herewith the annual report of the Department of Zoology and Physiology for the year ending June 30, 1908.

There has been no change in the personnel of the department during the year.

The following schedule shows the arrangement of subjects, classes and instructors by terms, the number of students in each class being also indicated. Laboratory or field work is required in every subject and usually there are several divisions of each class for such work. This of course involves much repetition of the laboratory work and demands

a large amount of time on the part of the instructors, but in no other way can students be given the full value of the course. When two or more instructors are named for the same class the one first named has had charge of the laboratory or recitation work, the others assisting in the laboratory work.

SCHEDULE OF DEPARTMENT WORK—1907-1908.

Fall Term (1907).
- Physical Geography 1a. Agricultural Sub-Freshmen, 42 students (Myers, Kelton).
- Physical Geography 1b. Women Sub-Freshmen, 25 students (Kelton, Myers).
- Zoology 1a. Agricultural Sophomores, 54 students (Barrows, Myers, Kelton).
- Zoology 2b. Women Juniors, 19 students (Barrows, Kelton).

Winter Term (1908).
- Geology 1a. Agricultural Sophomores, 46 students (Barrows, Kelton).
- Anatomy 2. Women Sophomores, 28 students (Myers, Kelton).
- Anatomy 2. Women (special), 25 students (Myers, Kelton).

Spring Term (1908).
- Zoology 1a. Agricultural Freshmen, 75 students (Barrows, Myers, Kelton).
- Zoology 1b. Women Freshmen, 46 students (Barrows, Myers, Kelton).
- Zoology 3a. Agricultural and Forestry Seniors and Juniors, 6 students (Barrows).
- Zoology 3b. Women Seniors and Juniors, 4 students (Barrows).

Total number of students for the year 370.

The new course of studies which went into effect this year marks a noteworthy departure from previous schedules. Instead of two terms of required zoology in the sophomore year and two terms of elective geology in the senior year the new course requires one term each of zoology and geology, all additional work in these subjects being elective. Moreover the required work in zoology has been placed in the freshman year, while the work in anatomy and physiology, two terms of which were required formerly in the freshman year, has been reduced to a single term and this is not given until the sophomore year. This transposition of anatomy and zoology was contrary to the desire of the department, and a year's test of the plan only strengthens our opinion that it is contrary to the best interests of the student. Before taking up any course in general zoology the student should be familiar with the outlines of human anatomy and physiology, and should have considerable practice in the microscopic study and drawing of animal tissues. Under present conditions it becomes necessary to give students in zoology considerable instruction in the use of the compound microscope and in histology before they can proceed satisfactorily, thus still further shortening the already too brief course in zoology.

On the other hand the establishment of a required course in geology proves to be of decided advantage. Owing to the fact that no mineralogy is given in either the agricultural or forestry courses it becomes necessary to preface or accompany the work in geology with some elementary mineralogy, but this can be done with little difficulty, and the work accomplished during the past year was very satisfactory on the whole.

The lack of gas in the laboratory is a serious drawback to blowpipe work, but this was largely overcome by the use of candles, while attention to the strictly physical properties of minerals and rocks permitted the determination of most of the commoner forms.

The elective zoology given in the spring term (zoology 3a and 3b) consisted mainly of work in economic ornithology and mammalogy, and it is believed that the course, with a few minor changes, will prove both popular and valuable. Three lectures per week were given on the habits and economic relations of the more abundant and important birds and mammals, while two periods of two hours each per week were devoted to field work when the weather was favorable or to laboratory work at other times. The success of these first classes certainly warrants their continuance.

The large amount of teaching required under the new schedule has made it impossible to do much work in the museum beyond that which was absolutely necessary to prevent deterioration. The museum is already overcrowded, and practically all available space is now occupied with cases. During the year a notable accession to the collections was made in the gift to the college by the Broas heirs of the entire collection of mounted birds and mammals of the late Levi Broas, of Belding, Michigan. This collection comprises upwards of seven hundred specimens, many of which are either new to the museum or are better specimens than those we already possess. By removing poorer specimens from our shelves it will be possible to put on exhibition a part of this new collection, but by far the larger part of it will have to be placed in storage until some increase in museum space can be made. The time is not far distant when a new museum building will become an absolute necessity, but even before that is possible it will be necessary for the department to have an additional assistant who can give most of his time to the preparation and care of museum material, perhaps assisting also in the preparation of specimens to be used in the laboratories. I sincerely hope that such an addition to the department force may be practicable during the coming year.

Respectfully,

WALTER B. BARROWS,

Professor of Zoology and Physiology.

East Lansing, June 30, 1908.

REPORT OF THE DEPARTMENT OF ENTOMOLOGY.

President J. L. Snyder:

Following is a brief report of work done by the Department of Entomology during the year 1907-8.

Five courses were given besides a course of thirty lectures to the short course men in fruit work.

Course six, to the sophomore women, has not been given because the sophomore women have not as yet come under the new arrangement, but this course will be given next year.

The work of the department has been handicapped by lack of room. The farm department has been generous to a fault both in making room for us and in all other ways, but even then it has been difficult to so arrange matters as to provide for some of the work. The department looks forward to the time when the new Agricultural building will make it possible to expand.

The collection has steadily grown, both by the addition of new bred materials and by the identification and arrangement of material collected in the past.

During the year Mr. Zeno P. Metcalf has assisted very efficiently as instructor. He, however, received an appointment in another state at a substantial increase in salary and went to his new position in June. The writer wishes to express his appreciation and thanks for his able assistance in carrying on the work of the department. He also wishes to thank Miss Catherine Koch, student, for her accurate and diligent aid in mounting and arranging material in the collection, and in other ways.

Respectfully submitted,
R. H. PETTIT,
Professor of Entomology.

East Lansing, June 30, 1908.

REPORT OF THE VETERINARY DEPARTMENT.

President J. L. Snyder:

Dear Sir:—I have the honor of submitting the following report: The Department of Veterinary Science, of which I took charge the second week of October, 1907, has offered instruction in the rudiments of Veterinary Science to the following number of students:

Spring Term: Freshmen, 81, 2 hours per week; junior and senior electives, 48, 5 hours per week.

Winter term: Freshmen and sophomores, 56, $2\frac{1}{2}$ hours per week; junior and senior elective, 59, 5 hours per week. First year short course men, 90, 5 hours per week; second year short course men, 30, 5 hours per week.

Fall Term: Junior and senior electives, 53, 5 hours per week.

While it is impossible to equip the students with anything more than an idea of the importance and magnitude of this class of professional work, I have tried to impart to them a useful knowledge of the anatomy and physiology of the larger domestic animals, upon which they may build an understanding on the conformation and soundness of live stock, and stock judging, and make it possible for them to derive some benefit from the lectures upon medicine and surgery. Preventive and control measures have been considered in detail in connection with those diseases which are of importance in this state, and treatments have been outlined for the more common diseases occurring among farm animals.

Demonstration work has been limited to anatomical lectures upon

paper and dissected specimens, operations upon and treatment of animals belonging to the college herds, and post mortem demonstrations upon carcasses received by the Experiment Station for analysis. This last feature accompanied by frequent observations of normal carcasses during their college course will undoubtedly prove of value to the students in enabling them to detect diseased structures in slaughtered animals, and perhaps in some cases will render them competent to recognize the character of the disorders, especially in cases presenting lesions of tuberculosis, hog cholera, and verminous affections of the bowels.

Lectures to first year students were confined very largely to the exterior of the horse, special attention being paid to the principal unsoundnesses, and diseases which produce them, and to the principles underlying the practice of the horse-shoeing.

Both classes taking the winter short course, received daily lectures, and afternoon demonstrations during one week. These were received with encouraging interest. Both the short course and winter term were necessarily broken on account of my absence from the college to purchase horses for the farm department, and attendance at five institutes.

In addition to the class work mentioned, I assisted Prof. Shaw in the special live stock judging class during the fall term when considering the work upon horses.

During the year, the department's facilities for demonstration and practical work have been increased by the addition of surgical instruments and medicines, but the class room equipment is in need of considerable addition and repair. The department is in possession of several bound and unbound books, medical journals, and government and station publications. This literature should be cataloged so that it may be readily accessible, and a start has been made toward that end by the use of student labor, which has not proven wholly satisfactory. I hope that I may be provided during the ensuing year with sufficient stenographic and clerical assistance to accomplish the completion of the work begun and to care for the department correspondence which has at times suffered for lack of time on my part.

While the work in this department is a radical departure from the routine class work of a veterinary institution, I am pleased with its general nature and opportunity for study and expansion along lines of live stock. I appreciate the treatment received at your hands and for the cordial welcome by the faculty, and I hope that the department may continue to fill the important function in the college it has in the past under the very able management of Drs. Grange and Waterman.

Respectfully submitted,

L. M. HURT.

East Lansing, Mich., June 30, 1908.

REPORT OF THE MILITARY DEPARTMENT.

President J. L. Snyder:

Sir:—I have the honor to submit my report of the military department for the year ending June 23rd, 1908.

During the first half of the fall term, the new cadets were instructed in the school of the soldier, being divided into squads of eight and instructed by sophomore cadet corporals, the instruction being superintended by the senior cadet officers. The remainder of the old cadets were instructed in company drill, close order, by the junior cadet officers.

The last half of the fall term and the first half of the winter term, the new cadets were drilled in the armory under their cadet officers in the school of the squad and company.

The sophomores were given two lecture courses of ten lectures each, the first consisting of lectures on the Field Service Regulations and the second of lectures on the Drill Regulations.

The last half of the winter term, the various companies received each week, two hours instruction in company and platoon drill, the third hour being given to theoretical instruction in guard duty and small arms firing regulations. The cadet officers were instructed separately, particular attention being given to the company in battle.

At the end of each half term and term, I made a personal inspection of each organization and recorded the standing of each cadet, taking into consideration his attendance, military bearing and proficiency in drill.

The spring term opened April 7th, and the first out-of-door drill was had April 13th. A new company (F) was organized, making the cadet corps consist of a battalion of six companies, band, hospital corps and signal corps detachments, a total of 530 cadets.

Capt. G. A. Shelton, General Staff, U. S. Army, inspected the corps May 15th last. Although the corps had had only fourteen drills out-of-doors, I am very well pleased with the showing made.

Last November I received a letter of commendation from the Secretary of War, for the good showing made by the Corps of Cadets at the inspection, May 22nd, 1907. I feel this year, the Corps of Cadets made even a better showing. Five hundred and twenty-four cadets were in ranks, completely uniformed and equipped, 4 being absent and 2 sick. The military exercises ordered by the inspector were as follows: escort to the color, review, inspection, battalion drill, company drill in close and extended order and drill for the hospital corps detachment. The corps was prepared to execute the following exercises but was prevented by rain: dress parade, guard mounting, signal drill. It was also prepared to form a rear guard, advance guard and outpost.

During the spring term, the Corps of Cadets has been reviewed and inspected by Adjt. Gen. W. T. McGurrin, Inspector General Carl Wagner, and Brigade General R. J. Bates, Michigan National Guard. A competitive drill was also held, the judges being Colonel J. N. Cox,

Colonel Walter Rogers and Captain Roy Vandercook, of the Michigan National Guard.

The judges decided that Co. "B," Captain S. W. Horton, was the best drilled company, Co. "E," Captain J. R. Campbell, second and Co. "F," Capt. M. E. Hall, third.

The above mentioned officers of the State troops have commended in the strongest terms the work of the Corps of Cadets this year.

On Decoration Day, the entire corps proceeded to Lansing and took part in the street parade. The entraining and detraining of the corps by organization was well and promptly done. Before returning to the college, a dress parade was held in front of the State Capitol in the presence of a large and appreciative audience. On this occasion, the corps presented a splendid appearance and reflected credit upon the college as well as upon themselves. The department was very fortunate this year in securing the services of Mr. A. J. Clark, instructor in chemistry, as director for the band. The band composed of thirty cadets, playing the various necessary instruments, has made, during the year, an enviable record, both in their work in the military department and in their desire to help out the various college functions by adding to them their inspiring music.

The department, this year, obtained from the government six Springfield rifles, model 1903. This is a fac-simile of the very latest rifle, the caliber being .22 in place of .30. As a consequence, the cadets have taken a great interest in rifle practice and some very creditable scores have been made.

The object of the instruction in this department is to qualify the average graduate for a commission as lieutenant in the organized militia or volunteers. I consider the work as now carried on to be in a good, healthy condition and to accomplish its object.

In order to get good results in this department, it is necessary to make the work worth while to the seniors, with whom the drill is optional. As both the Agricultural and Engineering seniors now receive credit for drill, I don't think there will be any difficulty in getting the best equipped seniors to continue the work.

This year, 15 seniors elected drill as against 8 last year. Any of these men who desire are eligible to appear for examination Jan. 2nd, 1909, with a view of being appointed second lieutenant in the regular army.

Before closing my report, I desire to express my appreciation of the good work done by the following senior officers: A. W. Brewster, R. C. Brody, J. R. Campbell, R. H. Gilbert, M. E. Hall, S. W. Horton, S. F. Knigh, W. M. Rider, F. V. Tenkonohy and E. I. Wilcox.

Very respectfully,

F. W. FUGER,

Capt. 13th Inf., Comdt.

East Lansing, June 30th, 1908.

REPORT OF THE LIBRARIAN.

To the President:

Sir:—The following is the report on the library for the year ending June 30th, 1908. Ten hundred seventy-two bound volumes have been added to the library during the year, of which four hundred seventy-one were purchased, one hundred eighty-six were gifts, and four hundred fifteen came by binding.

Six hundred nine pamphlets and unbound volumes have been received, and acknowledged in all cases where donor was known. We therefore omit individual mention at this time.

We are indebted as follows for bound volumes:

American Baking Powder Ass'n 2.
American Hampshire Downs Ass'n, 1.
Beal, Dr. W. J., 5.
Burrows, Hon. J. C., 6.
Baker, Ray Stannard, 12.
Baker, Taylor Pub. Co., 1.
Cooley, F. S., 1.
Fletcher, Dr. S. W., 1.
Grolkass, Ernest, 1.
Howard, T. W., 1.
Holstein-Friesian Ass'n, 1.
Harrisburg Foundry and Machine Works, 1.
Iowa, State Board of Agriculture, 1.
Lexis, W., 1.
Michigan reports,
- State Board of Agriculture, 1.
- State Horticultural Society, 1.
- State Geologist, 5.
- State Board of Health, 2.
- Crop Reports, 2.
- Farmers' Institutes, 1.
- Supt. Public Instruction, 1.
- Labor Bureau, 2.
- Public Acts, 1.
- Senate Journal, 2.
- House Journal, 2.
- Supreme Court reports, 5.

Mich. Acad. of Science, 1.
Maine State Board of Agriculture, 1.
Missouri Botanic Gardens, 1.
Metropolitan Park Commissioners, 9.
N. Y. State Library, 10.
New S. Wales, 3.
National Education Ass'n, 1.
Ohio State Board of Agriculture, 1.
Prang Educational Pub. Co., 7.
Smithsonian Institution, 3.
Thompson, S., 1.
United States, Dept. of Agr., 8.
- Bureau of Commerce and Labor, 6.
- Bureau of Education, 5.
- Interstate Commerce Commission, 2.
- Labor Bureau, 2.
- Marine Hospital, 4.

Veterinary Dept., M. A. C., 4.
VanNorman, H. E., 1.
Wellcome Laboratories, 2.
Wisconsin Historical Society, 37.
West Va. Board of Agriculture, 1.

Three hundred nine periodicals, foreign and American are purchased by the college and placed in the reading room. In addition to these are the following, received either as gifts from publishers, or in exchange for college publications:

Adrian Times.
Agricultural Advertising.
Agricultural Gazette of N. South Wales.
Agricultural Journal, India.
Agricultural Ledger, India.
Agricultural Students' Gazette, England.
Allegan Gazette.
American Agriculturist.
American Cheesemaker.
American Economist.
American Institute Electrical Engineers, Proceedings.
American Missionary.
American Poultry Advocate.
American Sheepbreeder.
American Sugar Industry.
American Swineherd.
American Thresherman.
Ann Arbor Argus.
Arboriculture.
Armada Graphic.
Battle Creek Journal.
Bear Lake Beacon.
Big Rapids Herald.
Canadian Horticulturist.
Cattle Specialist.
Chicago Dairy Farmer's and Drover's Journal.
Chicago Packer.
Christian Herald.
Church Helper.
Civic News.
Cornell Countryman.
Congressional Record.
Country Gentlemen.
Daily Tribune.
Electrical Times.
Farm and Fireside.
Farm and Home.
Farm Life.
Farm News.
Farmers' Advocate.
Farmers' Guide.
Farmers' Tribune.
Farmers' Voice.
Farming World.
Florists' Exchange.
Fruit Grower's Journal.
Garden.
Garden Magazine (formerly Farming).
Gleaner.
Gleanings in Bee Culture.
Grand Ledge Independent.
Hillsdale Leader.
Hillsdale Standard.
Hoard's Dairyman.
Holstein-Friesian Register.
Holstein-Friesian World.
Home and Farm.
Homestead.
Horse Shoers' Journal.
Horse World.
House and Garden.
Improvement Era.
Indian's Friend.
Indiana Farmer.
Ionia Sentinel.
Jersey Bulletin.
Johns Hopkins Univ. Circulars.
Journal of Agriculture, Australia.
Journal of Agriculture, Victoria.
Journal of Agriculture, Western Australia.
Kalamazoo Telegraph.
Kansas Farmer.
Kimball's Dairy Farmer.
Lansing Journal. (Daily.)
Lawton Leader.
Lewiston Journal.
Live Stock Journal. Chicago.
Live Stock Report.
Living Church.
Mark Lane Express.
Michigan Farmer.
Michigan Mirror.
Midland Republican.
Milchwirtschatliches Centralblatt.
Missouri Valley Veterinary Bulletin.
Moderator Topics.
Morenci Observer.
Mystic Worker.
Western Society of Engineers, Proceedings.
Williamston Enterprise.
Wilson Bulletin.
Women's Home Companion.
Ypsilantian.

The M. A. C. Record exchanges are also placed in the reading room, and in exchange for our catalogue we receive the catalogues and registers from the leading institutions of the country; these are filed in the librarian's office.

The publications of the various experiment stations of the country, and of the U. S. Dept. of Agriculture are also received and filed.

In March of this year Congress passed an act making the libraries of all Land-grant colleges "Depositories" for all publications issued by the government. Under this act the college is receiving a large amount of matter, much of which is valuable to us, but which, because of our present crowded condition, must be placed in storage, and therefore, not available for use. It is to be hoped that in the near future we may have a new library building, large enough to provide for our present needs, and to properly care for the accumulations of a rapidly growing library for many years to come.

The library hours have been materially increased during the year. We have been carrying out the following schedule of hours for about half of the year:

Daily, 7:30 to 12; 12:20 to 6; 6:20 to 9.

Sundays, 10 a. m. to 2 p. m; 3 to 5 p. m.

The library was in charge of Mr. Joseph Rosen, a senior, during the extra time it was open, and we feel that all appreciated his efficient services.

In February our assistant was offered and accepted a position in the U. S. Dept. of Agriculture, Bureau of Plant Industry. We were sorry indeed to lose Miss Feldkamp, who had served the library faithfully. She was succeeded by Miss Agnes Crumb, who came to us from the office of the Secretary of the College, and who, we believe, is giving quite general satisfaction.

The number of books drawn from the library during the year was four thousand eight hundred seventy-seven. The largest number taken out during any one month was five hundred seventy-five; the lowest number was one hundred forty-one.

No record is made of books used in the room.

Fines to the amount of $34.25 have been collected.

To the library of the Experiment Station two hundred sixty-nine volumes have been added. Of these fifty were purchased, three came as gifts, and two hundred sixteen by binding.

The College library now contains 26,792 volumes. The Station library, 2,666 volumes. Total in both libraries, 29,458 volumes. This number includes all books in department libraries, so far as they have been catalogued.

Respectfully submitted,

LINDA E. LANDON,

Librarian.

East Lansing, June 30, 1908.

REPORT OF THE DEPARTMENT OF PHYSICAL CULTURE.

To President J. L. Snyder:

The following is the report for the Department of Physical Culture and Athletics for the year ending June 30th, 1908.

It has been the aim of the department throughout the year to interest as large a number of the young men as possible into taking some work in the department, as well as to furnish wholesome recreation to the young men and the college community. With this object in mind an effort has been made to widen the range of the work.

As has been noted in previous reports, the physical culture branch of the work is curtailed seriously on account of having no gymnasium and no regular time available for the work. This lack of space and time has made it impossible to reach a large number of the young men. However, the usual work with Indian-clubs, dumb-bells, bar-bells, free arm and breathing exercises was offered, while all the recreative exercises, such as hand-ball, fencing, wrestling, apparatus work, tumbling, indoor baseball, etc., were promoted as far as possible. In the several branches of athletics, baseball, football, basket-ball, track and tennis, a very large number of the young men were induced to take part by the encouragement of inter-hall, inter-class, inter-department, and inter-society contests, in addition to the maintaining of the representative college team in each branch. The college teams all had successful years, easily leading all the state colleges in the major sports, football, baseball, track and basket-ball; not a defeat being suffered at the hands of any state college in any of these branches during the year. Considerable prominence and publicity was also secured by the defeat of Wabash in football, Notre Dame University in a dual track meet and by the work of the track team in the Western Conference Meet in Chicago.

The Third Annual Invitation Interscholastic Meet held on the college grounds May 18th, under the auspices of the department, was unusually successful. Twenty-nine high-schools of the state sent representatives and several hundred high school students from all parts of the state spent the day at the college.

The athletic field has been materially improved during the year. The grand stand was moved to a more advantageous location, a substantial bleacher was built, adding considerably to the seating capacity of the field, the cement bridge and approach to the field was completed, while a considerable amount of time and money was spent in building a retaining bank at the east end as a protection against high water and in improving the cinder track and the general equipment.

A considerably larger proportion of the young men took advantage of the privileges of the bath house this year than heretofore and the fees from this source have been ample to take care of the running expenses of the department.

In concluding my report, I want to again call attention to the neces-

sity of a gymnasium that the physical culture branch of the department may be brought up to the place it should hold.

Respectfully,
C. L. BREWER,
Director.

East Lansing, June 30th, 1908.

REPORT OF DEAN OF SPECIAL COURSES.

President J. L. Snyder:

Below is given a report of the Special Courses for the winter of 1907-8.

The Special Courses cover four general subjects, General Agriculture, first and second years, Creamery Management, Cheese Making and Fruit Growing.

The course in General Agriculture, continuing for eight weeks, with an enrollment of eighty-nine for the first year, covered work along the lines of live stock, veterinary medicine, carpenter and blacksmith shop, soils and crops, feeds and feeding, agricultural chemistry and fruits.

The second year in General Agriculture included, besides advanced work in the subjects above mentioned, butter making, milk and its products, corn and seed judging, farm engineering, poultry culture, business arithmetic and bookkeeping, bacteriology and entomology; many of these being elective. The enrollment for this course was thirty-two.

The Creamery Course, open only to men who have had experience for at least one season, aims to improve the butter makers now in creameries, not to fit young men without experience to go into the business. The course during the past year, with an enrollment of fifty-nine and conducted by Instructors McFeeters and Liverance, and others, covered work in business methods, dairy bacteriology, chemistry and physics of milk, grading gathered cream, butter judging and creamery principles, the afternoon hours being spent in the butter room in practical work.

The Cheese Course began immediately after the close of the Creamery Course and lasted four weeks with an enrollment of eight. The bulk of the time was spent in practical work. The student was taught to detect tainted milk, how to handle milk for the production of cheese, the use of starters and care of same. Lectures were given on the treating and controlling of germs, chemistry and physics of milk, the Babcock test, etc. Men who have had experience are invited to take this course.

A two weeks course was given in Fruit Growing, covering all phases of the business of growing fruit successfully. Nineteen enrolled for this course.

The value of these courses has increased as room and facilities for work have been secured and the interest and energy displayed the past winter have not been equaled any previous year.

These courses were completed under the direction of Mr. C. D. Smith, formerly Dean of the Short Courses, but now president of an agricultural college in Brazil. I am simply assuming the responsibility of making this statement for him.

Yours respectfully,
ROBERT S. SHAW.

East Lansing, Mich., June 30, 1908.

REPORT OF THE SUPERINTENDENT OF FARMERS' INSTITUTES.

To President J. L. Snyder:

Sir:—During the past year County Farmers' Institutes have been held in seventy counties in Michigan, under the rules laid down by the State Board of Agriculture. In addition to these county meetings, which with few exceptions have been continued for two days, one-day institutes have been held in sixty-three counties. Besides these regular institutes a large number of special meetings have been held relating to sugar beet growing, live stock husbandry, etc.

A Normal Farmers' Institute was held at the college in November, just before the opening of the regular institutes and during the spring a Railroad Institute Train was run for nine days, making fifty-four stops.

The regular institutes have been conducted on much the same lines as in previous years. The local arrangements have been left almost entirely to the county institute society officers, the vice-presidents acting as local managers for the one-day institutes. This method has been in operation for nearly fourteen years and has given excellent satisfaction. The success of the meetings depends very largely upon the interest taken by the local officers and I am glad to report that with few exceptions they have not failed in their duty. To arrange a series of institutes takes a considerable amount of time and except in one or two cases where the secretaries receive a small percentage of the membership fees, they serve entirely without compensation and in many instances pay their own expenses.

It can be truly said that the interest taken by the farmers in general in the institutes was never surpassed in Michigan.

The newspapers have been very helpful in advertising the meetings and, not only printed notices regarding the speakers, but reported the proceedings and gave abstracts of the papers. In several newspapers two or three columns were devoted for two or three weeks to these reports and thus gave to the farmers who either could not or would not attend the meetings, the pith of the papers and discussions.

The attendance in nearly every case, when attention had been given to advertising the meeting and the conditions were favorable, was all that could be asked and in a large number of instances the halls were filled and hundreds turned away. Up to the last of January it looked as though the total attendance would be fully twenty-five per cent

larger than during any previous year, but the weather during the last week in January and much of the time in February was such as to make it almost impossible to carry on the institute work, in fact, in some cases more than half of the meetings had to be given up and those that were held were but lightly attended, it being practically impossible for the farmers to reach the halls. From the fact that during the weeks when the weather was so unfavorable a large number of meetings were scheduled, the attendance in a considerable part of the counties was less than last year and the total attendance was greatly reduced, but notwithstanding this it exceeded that for 1906-7, by about 14,000, being more than 135,000.

Until last year the railroads have furnished transportation to the lecturers at one-half the usual fare, but this year it has been necessary to pay full fare, thus considerably increasing the expenses of holding the meetings.

Before selecting lecturers or topics for the Farmers' Institutes, the officers of each county institute society are requested to furnish a list of the topics they wish discussed, and speakers are secured who can handle the topics chosen and who will be likely to give satisfaction. In selecting speakers upon topics relating to practical farming or fruit growing, an endeavor is made to secure those who have been successful in actual practice. During the year it has been found necessary to add several speakers to the list and these have given excellent satisfaction, although those who have been on the force for a number of years, being better known, are naturally more called for.

In a large number of counties the cooperation with the county superintendent of schools has been continued as, when proper arrangements are made, the results have been very satisfactory. It has been customary for the county commissioner of schools to take part in the meetings and in a large number of cases a speaker has been furnished from the school funds for the afternoon and evening sessions of the one-day institutes. During the forenoon and early part of the afternoon, the speaker thus furnished, who is generally from one of the normal schools or is the commissioner in an adjoining county, visits with the local commissioner, the schools in the districts near where the institutes are being held, and reaches the hall about the middle of the afternoon for a talk upon educational matters and another talk in the evening.

One state speaker is furnished from the farmers' institute force for the one-day institutes and he is expected to speak once at each session, as well as to take part in the discussions and answer questions that may be referred to him. It is expected that one local speaker will be furnished for the morning and afternoon sessions to talk upon farm topics as well as one for the evening, preferably a lady upon some topic relating to the home. In arranging the program it is always planned to have one or two pieces of music for the afternoon and evening and readings can also be placed upon the program for each session. It will generally be desirable to have all of the topics of the forenoon and two of those in the afternoon relate to practical farming, but nothing can be more desirable than to have one of those in the afternoon and one or two in the evening along educational lines, particularly if the cooperation of the county commissioner or local principal can be secured. For the two-day meetings, much the same

plan for the program has been used, but it has been customary to send at least three state speakers, one of whom has generally been a woman. This made it possible to furnish a speaker for nearly every topic on the program, especially as the force has been supplemented in nearly every county by speakers upon "Good Roads" and "Education."

For this help I wish to acknowledge the hearty and helpful cooperation of Highway Commissioner Earle who devoted almost his entire time from the first of December to the first of March to attending the farmers' institutes, and as Deputy Commissioner F. F. Rogers or some of the assistants were also in the field for several weeks, it made it possible to have a talk by a "Good Roads" expert at nearly all of the county and a part of the one-day institutes.

At all the meetings where it was possible for him to be present in the evening, Commissioner Earle also gave an address, "Individuality," which was enjoyed by all and cannot fail to be helpful and inspiring to young people.

Through the kindness of the State Librarian, Mrs. Mary C. Spencer and the State Library Commission, it was made possible for Professor R. D. Bailey of Gaylord, for many years school commissioner of Otsego county to attend some forty of the institutes and present the plan arranged by the Library Commission for the loan of traveling libraries. Professor Bailey also spoke at a large number of meetings upon education for the young, using "Schools out of School" as the topic of his address.

Valuable assistance was also furnished by the State Department of Public Instruction and the Normal Schools.

A considerable amount of work has also been done by the members of the College faculty and Experiment Station staff although prevented by their college duties from making extended trips. Among those who took part in the work were President J. L. Snyder, Professor C. D. Smith, Professor R. S. Shaw, Professor J. A. Jeffery, Dr. L. M. Hurt, Dr. T. C. Blaisdell, Prof. J. Fred Baker, Prof. R. H. Pettit, Miss Pearl MacDonald, Mr. J. G. Halpin and Mr. F. H. Sanford.

Mr. L. M. Geismar, superintendent of the Upper Peninsula Experiment Station has attended most of the meetings in the Upper Peninsula and Prof. J. F. Wojta, principal of the Menominee Agricultural School, kindly conducted a one-day institute in Delta county. Mr. F. A. Wilken, superintendent of the South Haven Experiment Station attended a considerable number of institutes along the "Fruit Belt."

For the two weeks during the latter part of January, we were fortunate in securing the services of Mr. J. P. Davis of Sheridan, Indiana. Mr. Davis spent two weeks in institute work in Michigan in 1907, and the reports were so generally favorable that it was felt that no mistake could be made in securing him for this year. While Mr. Davis is especially at home upon matters relating to corn culture, he has also proven a very acceptable speaker upon quite a number of farm topics and during both years has given the very best of satisfaction.

For a number of years there has been a growing interest in the subject of commercial fertilizers but for the most part speakers who had made use of them and were prepared to talk from a practical standpoint were not competent to handle the scientific side of the question. This season, however, we were very fortunate in being able to secure

the assistance of Prof. H. A. Huston of Chicago, who for nearly twenty years was chemist of the Indiana Experiment Station, and in charge of the Fertilizer Control work of that state. For a number of years also he has been carrying on experiments in the northern part of Indiana and various parts of Michigan, and no one is better posted regarding the needs of our soil and the amounts of plant food required for the various crops. Prof. Huston was present at eight institutes during the winter and spoke upon "Commercial Fertilizers, Their Use and Abuse."

NORMAL INSTITUTE.

As preliminary to the regular institute work, the third annual Normal Institute was held at the college, November 19 to 22nd. The meeting was attended by practically all of the institute lecturers; the one or two who failed to attend being kept away by reasons beyond their control. The time was spent in discussing methods of conducting the institutes and in listening to addresses and lectures by the college faculty. The subjects treated were recent discoveries in the science of agriculture and the progress that has been made in various lines.

This was the third meeting of the kind and, as in previous years, the lecturers stated that they received much benefit from the sessions and that they were greatly aided in carrying on the institute work during the winter.

FARMERS' INSTITUTE SPECIAL.

Arrangements were made in March, 1908, for a special institute train over a portion of the Pere Marquette system from Lansing to Grand Rapids and thence to New Buffalo and from there to Detroit over the main line of the Michigan Central, returning to Lansing by way of Saginaw. Three days were spent upon the Pere Marquette and six on the Michigan Central and fifty-four stops were made.

The train furnished by each road consisted of a locomotive, two baggage cars and two and three coaches. Representatives of the passenger and operating departments of the Michigan Central accompanied the train over its line.

The speakers upon the train were:

Mr. W. F. Raven, Brooklyn, Dairying, nine days.

Prof. J. A. Jeffery, M. A. C., Corn culture, one day.

Mr. F. W. Howe, M. A. C., Corn Culture, eight days.

Mr. J. G. Halpin, M. A. C., Poultry Raising, nine days.

Mr. C. P. Halligan, M. A. C., Spraying and Fruit Growing, four days.

Mr. T. A. Farrand, Eaton Rapids, Spraying and Fruit Growing, four days.

Hon. H. S. Earle, Lansing, Good Roads, eight days.

Mr. F. F. Rogers, Lansing, Good Roads, one day.

Prof. H. A. Huston, Chicago, Fertilizers, two days.

Mr. E. B. Reid, special student in Agriculture and Mr. Howard Taft, '09, assisted in demonstrating and had charge of Milk Testing.

The stops at the different stations ranged from one hour to an hour and fifteen minutes and from thirty to forty minutes was taken up

by the lecturers in the coaches; the remaining time being given to the examination of the exhibits in the baggage cars.

The exhibits were similar to those used in 1907, a full description of which was given in the last report. In addition, however, there was a very interesting exhibit of road-making materials with drawings and photographs of state reward roads under construction. Much interest was also shown in the exhibit of commercial fertilizers.

As in previous years, particular attention was paid to corn culture and to show the importance of curing and testing seed corn, several testing boxes were carried. The seeds under test showed very conclusively the poor condition of the seed corn of the average Michigan farmer. In one box there were samples taken from the college corn crib, from corn that had been purchased for seeding and crib corn that had been sent in to the college by farmers for testing. In no case did more than twenty-five per cent germinate, while seed corn selected in the college fields last fall, identical with that taken from the crib this spring but which had been carefully dried, gave a test of more than ninety per cent. In other words, while crib corn would give only about one stalk in two hills, practically a perfect stand could be secured where the corn was properly cured.

The importance of testing each ear of seed corn was also shown very nicely as some of the ears taken from the crib upon which none of the kernels germinated were, so far as the eye could see, fully as good as other ears which would give a fairly good stand.

The interest and attendance at the stopping points for the Corn Special were, in most cases, beyond anticipation, although the attendance was somewhat reduced between Grand Rapids and Benton Harbor by the cold, blustering, rainy weather which prevailed, and while in the vicinity of Battle Creek, the day being Saturday, many Adventist farmers did not attend.

At several places, especially upon the Bay City and Saginaw division of the Michigan Central much interest was shown by the teachers and pupils of the schools, many of whom visited the train and examined the exhibits.

Some very flattering reports regarding the work done and the good accomplished by the Institute Trains of 1906 and 1907, have been received and it is confidently expected that even greater benefits will be secured from that run in 1908 by the farmers who attended its sessions.

THE ROUND-UP INSTITUTE.

From February 25th to 28th inclusive, the Thirteenth Annual Round-up Farmers' Institute was held in the college armory.

Although the weather at the college was fairly pleasant except upon the opening day, severe storms in the neighboring counties made it difficult or impossible for many farmers to leave home and this considerably reduced the attendance, although upon portions of Wednesday and Thursday every seat in the armory was occupied.

Special features were arranged for each session. Among these the principal ones were the Forestry session on Tuesday afternoon, the Agricultural sessions on Wednesday forenoon and afternoon, the Corn sessions of Thursday forenoon and afternoon, the Live Stock session

of Friday forenoon and the Dairy session of Friday afternoon. Several of the state lecturers were upon the program as well as quite a number of the college faculty. In addition to these and others mentioned heretofore were Chas. B. Blair and Hon. Chas. W. Garfield of Grand Rapids, Prof. J. W. Toumey of the Yale School of Forestry and Prof. R. S. Kellogg of the U. S. Department of Agriculture on forestry topics; Prof. A. L. Quaintance of the U. S. Department of Agriculture on orchard insects; Prof. P. G. Holden of Ames, Iowa on corn culture and Prof. Chas. S. Plumb of Columbus, Ohio, upon the care of hogs and cattle.

The musical portion of the program was arranged by Miss Louise Freyhofer, instructor in Music at the college. One or two pieces of music were provided for each session and formed a considerable part of the program for each evening. The music by the M. A. C. band under Instructor A. J. Clark was particularly enjoyable. The M. A. C. orchestra also gave delightful selections. On Tuesday evening the M. A. C. chorus gave a selection from the Oratorio of St. Paul and the M. A. C. choir, on Thursday evening, gave the Song of the Vikings. Instrumental music was also furnished by Mr. C. Clippert, Miss Zae Northrup, Mr. E. Hallock, and Miss Edna Hopsen, students at the college. Prof. A. J. Patten and Instructor F. W. Howe, Mr. Ray Turner, Mr. E. E. Nies, Miss Lyla Smith and Miss Mary Allen gave vocal selections. Miss Mildred Fletcher of Lansing also gave two vocal selections. Readings by Prof. E. S. King were also greatly enjoyed.

Representatives of most of the college classes also took part in the program and it proved an interesting feature of the meeting. For the Horticultural section, brief talks were given by F. M. Barden, H. H. Conolly and B. B. Pratt. A symposium on the oat was furnished by eleven students in Agronomy and a live stock demonstration was given by six seniors, while twenty-nine young ladies gave brief talks upon the form, structure and economic value of various plants from a botanical standpoint.

SUMMER INSTITUTES.

During the month of June several institutes have been held in the northern counties, and although the institute season was supposed to have closed with the Round-up Institute, they brought out a large number of farmers. Some of them were held in groves and were on a picnic plan. At each place the state speaker gave a talk in the forenoon and another in the afternoon upon farming topics.

On the whole it can be said that although it was reduced fully 15,000 in one week by unfavorable weather, not only has the attendance at the institutes this year been the largest ever recorded in Michigan, (and with one or two exceptions, and those in states which make considerably larger appropriations for farmers' institutes, it has never been equaled in any state), but the interest in institute work has never been better, and the local officers have never shown greater enthusiasm.

Under these conditions even better results can be hoped for during the coming year and the institutes should be even more helpful to the farmers of Michigan.

Respectfully submitted,

L. R. TAFT,

Superintendent Michigan Farmers' Institutes.

East Lansing, Michigan, July 1, 1908.

REPORT OF STATE INSPECTOR OF ORCHARDS AND NURSERIES.

To the State Board of Agriculture:

Gentlemen:—I herewith submit a report of my work for the past year as State Inspector of Nurseries and Orchards.

In accordance with the state law, the nurserymen and dealers in Michigan and the nurserymen who are residents of other states but who have agents within the State of Michigan, were early in July reminded of the requirements so far as the taking out of a license and inspection of stock were concerned. Most of them complied promptly and the others did so later on.

During August, September and October the stock growing in Michigan nurseries was inspected and was found in unusually good condition. Although the San Jose scale again appeared in a number of nurseries, it was far less prevalent than in 1906, and in several instances had entirely disappeared. This result was due largely to the pains taken by the proprietors to destroy infested trees and to the thorough spraying which the stock in infested nurseries received, although the effect of the freeze of October, 1906, had much to do with checking the spread of the scale in the nurseries as well as in the orchards. The stock sold from infested nurseries was fumigated with hydrocyanic acid gas and we have yet to know of a case in which the trees have been injured by this treatment, and the results have in every case been all that could be asked, as although more or less fumigation has been done for six or seven years, we have yet to find any live scale upon nursery stock that has been fumigated except when they were planted in the vicinity of infested trees.

In addition to the regular inspection given at the close of the growing season, the practice of previous years of looking over the stock of the more important nurseries in infested regions during the spring months to see that, on the one hand, the stock that was being sent out was in proper condition, and to note that the growing stock had been sprayed and it was not endangered by the surroundings, was continued.

INSPECTION OF ORCHARDS.

During the year many calls have been received from parties having orchard trees infested with scale. In many cases it was possible to

give the necessary instructions for the control of the scale without a personal visit, but in many others, visits were made to infested localities and the spread of the insect determined and measures taken for its control.

For the most part, local inspectors have only been appointed in sections where commercial fruit interests are important, but as reports have come in of the presence of the scale from townships which have had no inspectors, the attention of the township boards has been called to the requirements of the law and inspectors have been appointed. As many of them were unfamiliar with their duties, it has been customary to spend a day with them to explain these duties and assist them to become familiar with the appearance of the more troublesome insects and diseases and with the methods of combating them.

In the section of the state where the San Jose scale first made its appearance, in the counties of Kent, Allegan, Van Buren and Berrien, the fruit growers have not only become satisfied of the danger which threatens their orchards from the spread of this insect, but they have taken measures for controlling it by using lime-sulphur mixture. Where the remedy has been properly prepared and thoroughly applied, excellent results have been secured as in many orchards which were quite badly infested in 1906, no indication of the presence of the insect could be noticed, even upon the fruit, in 1907. Although it has been found in many orchards that were not known to be infested previously, comparatively little spread of the scale has been noticed. It has not yet made its appearance north of Kent and Gratiot counties, except in one place in Oceana county. Specimens from a single tree in Benzie county have been received, but it is evident that they were upon the tree when it was planted and it is not known to have spread.

PEACH YELLOWS.

For a number of years the yellows has been confined largely to the lake shore counties south of Mason county. In sections where the industry was of importance, the owners of the orchards have been able to hold the disease in check so that the losses have been very light, but during the past year it has made its appearance in a number of counties away from the lake shore in which its presence had not been known and where the owners of the orchards not being familiar with the appearance of the disease did not recognize the danger and hence took no steps to control it. In such cases the losses have been very large and in many cases entire orchards have been wiped out. This had been the case in isolated points in Barry, St. Joseph, and Calhoun counties. The disease is also doing some damage in the western portion of Newaygo county but up to the present time it does not seem to have obtained much of a foothold in Mason county to the north although it is evidently working in that direction. Visits have been made to all infested points and the appointment of township commissioners has been brought about and endeavors made to impress the owners with the importance of taking prompt and decided action to control the disease.

LIST OF LICENSED NURSERIES.

I append herewith a list of the nurseries licensed to do business during the year ending July 31, 1908. This list consists of seventy-six nurseries, thirty-five dealers and thirty-eight foreign nurseries.

Respectfully submitted,

L. R. TAFT,

State Inspector of Orchards and Nurseries.

East Lansing, June 30, 1908.

MICHIGAN NURSERYMEN, 1907-1908.

Alferink, Alfred, Holland, R. 8.
Allen, R. E., Paw Paw, R. D.
American Nursery Co., Kalamazoo.
Augustine, L. D., St. Joseph.
Baldwin, C. E., 469 Upton Ave., Battle Creek.
Baldwin, O. A. E., Bridgman.
Blake, William, Niles, R. 6.
Bragg, L. G. & Co., Kalamazoo.
Central Michigan Nursery Co., Kalamazoo.
Central Nursery & Floral Co., Kalamazoo.
Collins, W. E., Fennville.
Coryell, R. J., Birmingham.
Culver, O. B., Colon.
Curtis, L. T. & Sons, Flint.
Dean, Geo. N., Shelbyville.
Dow, H. C., Kibbie.
Dressel, G. L., Frankfort.
Dunham, E. W., Stevensville.
Dutton, Chas. S., Holland.
Ferrand, E. & Son, Vinewood Ave., Detroit.
Flansburgh & Potter Co., Leslie.
Grand Rapids Nursery Co., Grand Rapids, 48 Livingston.
Greening Nursery Co., Monroe.
Gustin, C. F., Adrian.
Haines, J. W., Eaton Rapids.
Hamilton & Sons, A., Bangor.
Hart Nursery, Hart.
Havekost, G. H., Monroe.
Hawley, Geo. A., Hart.
Hawley, H. E., So. Haven.
Helmer Farm Nursery, Battle Creek, R. 6.
Hodges, Ezra & Son, Mayville.
Husted, N. P., Lowell.
Ilgenfritz, Chas. A., Monroe.
Ilgenfritz, I. E., Sons Co., Monroe.
Jaquay Co., Irving, Buchanan.
Jeffery, James, Sr., Kalamazoo.
Kalamazoo Nurseries, Kalamazoo.
Kellogg Co., The R. M., Three Rivers.

Knight & Son, David, Sawyer.
Lake Shore Nursery Co., St. Joseph.
McKee, H. R., Coloma.
Maudlin Nursery, The E., Bridgman.
Michigan Nursery Co., Monroe.
Michigan Nursery & Orchard Co., Kalamazoo.
Muchmore, Wm. O., Augusta.
Munson & Son, W. K., Grand Rapids.
Negaunee Nurseries & Greenhouses, Negaunee.
Nelson, J. A., & Son, Paw Paw.
Newaygo County Nursery Co., Fremont.
Newell, Reuben, 16 Piquette Ave. E., Detroit.
Paw Paw Valley Nursery Co., Coloma.
Peninsula Nursery Co., Benton Harbor.
Pontiac Nursery Co., 240 Woodward Ave., Detroit.
Postum Cereal Company, Battle Creek.
Prater, Jr., G. E., Paw Paw.
Prudential Nursery Company, Kalamazoo.
Schild, H. J., Ionia.
Singer, W. H., Lapeer.
Smith, E. J., Cheboygan.
Sodus Nursery Co., Sodus.
Speyers, Chas. M., Willis.
Spielman Brothers, Adrian.
Stoddard, L. H., Kalamazoo, R. 12.
Stone, John & Son, Hillsdale.
Tossy & Co., L. F., 84 Baltimore Ave., Detroit.
Taplin, Stephen, W. Fort St., Detroit.
Thrasher, C. D., Hamburg.
Utter, Jay J., Bravo.
Weller, Barend H., Holland.
West Michigan Nurseries, Benton Harbor.
Weston, A. R. & Co., Bridgman.
Whitten, C. E., Bridgman.
Wildemere Gardens, Highland Park.
Wise, Ralph., Plainwell, R. D.
Wooll & Tillotson, Elsie.

MICHIGAN NURSERY DEALERS.

Beattie, Thomas, 187 Sidney Ave., Detroit.
Cole, Levant, Battle Creek.
Cross, Eli, Grand Rapids.
Cross, James A., Nunica, R. D.
Cukerski, Wendell L., So. Wealthy Ave., Grand Rapids.
Cutler & Downing, Benton Harbor.
Davison Nursery Co., Davison.
Drought, William, Douglas.
Enders & Dukesherer, Coloma, R. 2.
Essig, W. W. & Co., Jones Building, Detroit.
Freyling & Mendels, 891 Wealthy Ave., Grand Rapids.
Herpolsheimer Company, Grand Rapids.

Heyboer, A., 867 Sutton Ave., Grand Rapids.
Hibbler, Edwin B., 12 Montcalm St., E. Detroit.
Hudson, J. L., Co., Detroit.
Kimball, D. S., 47 Aurelia St., Detroit.
Knapp, W. F., Monroe.
Kooyers, John A., Holland.
Lamson & Rood, Covert.
McGrayne & Van Houtan, No. 1 Cadillac Sq., Detroit.
Maplewood Violet & Nursery Co., Lansing.
Merrill, W. F., South Haven.
Miller, Abner, Fennville.
Oregon Nursery Company, Detroit.
Pearson, D. S. & Co., Grand Rapids.
Sanders & Vanderhoof, Berrien Springs.
Smith, Henry, Grand Rapids.
Souter, Geo. H., Holland.
Strittmatter, Adolph, 488 Chene, Detroit.
Sweet, L. H., Carsonville.
Trankla, & Co., Chas., Grand Rapids.
Washington Nursery Co., Detroit.
Webb & Co., D. S., Fife Lake.
Westgate Nursery Co., H. L., Monroe.

FOREIGN NURSERIES.

Allen Nursery Co., Rochester, N. Y.
Bogue, Nelson, Batavia, N. Y.
Brown Brothers Company, Rochester, N. Y.
Bryant Brothers, Dansville, N. Y.
Bryant & Son, Arthur, Princeton, Illinois.
Cartwright, I. D., 22 St. Clair Bldg., Toledo, Ohio.
Charlton Nursery Company, Rochester, N. Y.
Chase Brothers Company, Rochester, N. Y.
Chase, Chas. H., Rochester, N. Y.
Chase Nurseries, The, Geneva, N. Y.
Costich Company, G. A., Rochester, N. Y.
Dansville Nursery Company, Dansville, N. Y.
Franklin Davis Nursery Co., Baltimore & Paca Sts., Baltimore, Md.
Fairview Nurseries, Rochester, N. Y.
First National Nurseries, Rochester, N. Y.
Harman Company, M. H., Geneva, N. Y.
Hawks Nursery Company, Rochester, N. Y.
Henby & Son, J. K., Greenfield, Ind.
Herrick Seed Company, Rochester, N. Y.
Home Nursery Company, Bloomington, Illinois.
Hooker & Wyman Company, Rochester, N. Y.
Jewell Nursery Company, Lake City, Minn.
Knight & Bostwick, Newark, N. J.
McGlennon & Kirby, Rochester, N. Y.
Miami Valley Nurseries, Phoneton, Ohio.
Perry Nursery Company, Rochester, N. Y.
Fairmount Nursery Company, Troy, Ohio.

Ringler Rose Company, 1112 Rector Bldg., Chicago, Ill.
Sherwood, Elmer, Odessa, N. Y.
Sidney Nurseries, Sidney, Ohio.
Spring Hill Nurseries, Phoneton, Ohio.
Standard Nursery Company, Rochester, N. Y.
Stark Brothers Nurseries & Orchards Co., Louisiana, Mo.
Van Dusen Nurseries, Geneva, N. Y.
Western New York Nursery, Rochester, N. Y.
Whitney & Company, G. W., Dansville, N. Y.
Willett, Eugene, No. Collins, N. Y.
Wright Nursery Co., J. M. T., Portland, Indiana.

TWENTY-FIRST ANNUAL REPORT

OF THE

EXPERIMENT STATION

OF THE

STATE AGRICULTURAL COLLEGE OF MICHIGAN

UNDER THE HATCH AND ADAMS ACTS

FOR THE

YEAR ENDING JUNE 30, 1908

For members and organization of the State Board of Agriculture in charge of the Station, and list of officers, see page 11 of this volume.

EXPERIMENT STATION.

REPORT OF SECRETARY AND TREASURER.

The following account shows the receipts and expenditures of the Experiment Station for the year ending June 30, 1908:

		Dr.	Cr.
July 1, 1907—To	balance	$473 91	
July 8, 1907	received from U. S. Treasury	6,000 00	
Oct. 9, 1907	received from U. S. Treasury	6,000 00	
Jan. 11, 1908	received from U. S. Treasury	6,000 00	
Apr. 12, 1908	received from U. S. Treasury	5,326 10	
June 30, 1908	license fees, 156 brands com'l fertilizers and 1 analysis	3,130 00	
	farm receipts, etc	2,234 30	
	from State appropriation, South Haven	1,500 00	
	from State appropriation, U. P. Experiment Station	3,000 00	
	South Haven Experiment Station receipts	343 53	
	U. P. Experiment Station receipts	1,970 41	
	from State appropriation for live stock	20,000 00	
	from State appropriation for live stock—poultry	6,000 00	
	by disbursements as per vouchers filed in the office of the State Auditor General		$54,048 33
	Balance on hand		7,929 92
		$61,978 25	$61,978 25

Forty-seven thousand copies of each regular station bulletin are now issued of which about forty-five thousand are required for the regular mailing list. Aside from these a considerable of special and press bulletins are issued each year.

DISBURSEMENTS ON ACCOUNT OF U. S. APPROPRIATION.

	Hatch Fund.	Adams Fund.	Total.
Salaries:			
Director and administrative officers, No. employed 7.	$2,778 65		
Scientific staff, No. employed 6	1,879 30	$2,610 00	
Assistants to scientific staff, No. employed 6	1,038 42	2,292 90	$10,599 27
Labor:			
Monthly employees	$3,057 00	$943 00	
Monthly, weekly, daily and hourly employees as needed	2,202 03	421 72	6,623 75
Publications:			
Halftones, mailing lists, etc	$266 90		266 90
Postage and stationery:			
Postage	$193 81	$0 80	
Stationery	151 36		
Telegraph and telephone	4 23	82	351 02
Freight and express	$238 45	$139 90	378 35
Chemical supplies	$265 29	$38 38	303 67
Seeds, plants and sundry supplies:			
Agricultural	$180 55		
Horticultural	229 53	$27 00	
Botanical	16 80		
Entomological	92 38	1 40	
Bacteriological	146 45	208 77	
Chemical	81 93	217 41	
Director's office	111 14		
Office of secretary	21 08		
Veterinary	11 05	2 61	1,348 10
Feeding stuffs	$267 27	$189 48	456 75
Library	$685 40	$51 80	737 20
Tools, implements and machinery:			
Repairs	$41 28	$0 65	
New purchases	205 65		247 58
Furniture and fixtures:			
One cabinet	$3 50		
One vertical file	39 88		
Various other purchases	25 90		
Twenty-four cylinder jars		$7 20	$76 48
Scientific apparatus:			
One copper distil	$51 30		
One electro drying oven	55 00		
Two dozen lantern globes	10 00		
Various purchases	196 46	$391 64	
One micro planer		24 00	
One binocular microscope		46 80	
Ten moist chambers		11 50	
Eight dozen long necked flasks		15 85	
One filtering apparatus		90 00	
One combustion furnace		22 00	
One sterilizer		27 00	
One microscope stand		91 25	
One micrometer		90 00	1,122 80
Live stock:			
Cattle		$267 00	
Swine		246 75	
Sundries		2 85	516 60
Traveling expenses:			
In supervision of station work	$117 38		
In connection with investigations under the Adams Act		$344 25	
For other purposes connected with station work	191 40		653 03
Contingent	$5 88	$19 84	25 72
Buildings and land:			
Improvements	$137 35	$155 43	292 78
Total			$24,000 00

DISBURSEMENTS OF EXPERIMENT STATION MONEYS—OTHER THAN RECEIVED FROM UNITED STATES TREASURER.

Salaries	$2,092 55	
Labor	8,135 69	
Publications	36 76	
Postage and stationery	113 25	
Freight and express	683 31	
Heat, light, water and power	21 77	
Chemical supplies	161 79	
Seeds, plants, and sundry supplies	1,869 91	
Fertilizers	160 85	
Feeding stuffs	4,491 88	
Library	169 13	
Tools, implements and machinery	154 17	
Furniture and fixtures	3 50	
Scientific apparatus	557 35	
Live stock	7,206 85	
Traveling expenses	1,770 88	
Contingent expenses	17 98	
Buildings and land	2,497 21	
		$30,084 83
Balance on hand		8,603 82
Total		$38,688 65

REPORT OF THE DIRECTOR OF THE EXPERIMENT STATION.

President J. L. Snyder:

About the end of March, 1908, Director C. D. Smith resigned and left for Brazil to assume the duties of president of an agricultural college at Piracicaba, St. Paulo. At this time I was appointed Director with Dr. C. E. Marshall as Scientific and Vice-Director, hence my term of office has extended over but one quarter of the year which this report is supposed to cover. In large measure this year's work has been a continuation of that mentioned in the Director's report for 1907. As the various divisions of the Experiment Station are submitting individual reports, reference will be made only to the agronomy work which has been under the direct management of the director.

During the year the following bulletins were issued viz.:

Bulletin 248—Fertilizer Analyses. A. J. Patten, August, 1907.

Bulletin 249—Protection of Buildings from Lightning. A. R. Sawyer and L. J. Smith, August, 1907.

Bulletin 250—College Farm Buildings. R. S. Shaw and J. A. Jeffery, October, 1907.

Bulletin 251—Insects of 1907. R. H. Pettit, March, 1908.

Special Bulletin 38—Thrips on Oats. R. H. Pettit, July, 1907.

Special Bulletin 39—Pollination of Forced Tomatoes. S. W. Fletcher and O. I. Gregg, October, 1907.

Special Bulletin 40—Report of South Haven Sub-Station for 1906. L. R. Taft and F. A. Wilken, April, 1907.

Special Bulletin 41—Report of Upper Peninsula Sub-Station for the years of 1905-6. L. M. Geismar, April, 1907.

Special Bulletin 42—Bacterial Associations in the Souring of Milk. Charles E. Marshall and Bell Farrand, March, 1908.

Special Bulletin 43. The Solvent Action of Soil Bacteria Upon the Insoluble Phosphates of Raw Bone Meal and Natural Raw Rock Phos-

phate. Walter G. Sackett, Andrew J. Patten and Chas. W. Brown, March, 1908.

Special Bulletin 44—Michigan Varieties of Fruits. S. W. Fletcher, June, 1908.

Special Bulletin 45—Spraying Calendar. L. R. Taft and R. S. Shaw, May, 1908.

Special Bulletin 46—Report of South Haven Sub-Station for 1907. L. R. Taft and F. A. Wilken, May, 1908.

Circular No. 1—Alfalfa. R. S. Shaw, June, 1908.

Circular No. 2—The Babcock Test. W. B. Liverance, June, 1908.

FIELD CROP BREEDING.

The following is a brief statement of the field crop breeding work based on a report submitted by Mr. F. A. Spragg, in charge of the actual work.

The object is to procure pure or pedigreed strains from various varieties of wheat, oats, barley, beans, cowpeas, soy beans, alfalfa, clover, timothy, etc. Most of the original varieties contain individuals characterized by wide variation in form, habit and function. The pure strains must needs have pedigrees tracing to single plants. As some classes of plants are close fertile they may be planted side by side without danger of crossing but others require to be isolated or so grouped that crosses will either not occur at all or will not be harmful.

It is essential to have large numbers of individual plants to start from in order to furnish a wide range within which to choose individuals of marked excellence in conformity with the desired object. During the development of the individual plants they should be submitted to like conditions as far as possible, relating to space, soil, moisture, sunshine, etc.

The desirable qualities to be considered in selection are previously recorded as a guide. Large numbers of individual plants permit rigid selection along several lines at the same time. The selected plants furnish seed for individual plots the following year. When a number of pure strains have been developed to standards of desirable quality and uniformity and sufficient quantities of seed have been procured, they are then put on a comparative basis, not only among themselves but against standard varieties also as record yielding power. The next step is to increase the desirable ones and send them out to the farmers of the state.

WHEAT.

Variety testing has of course been in progress for many years. In 1906, Mr. M. Craig produced some hybrids which are being selected, improved and increased.

The plots of 1907 contain twenty-three commercial varieties planted in one hundred twenty-six beds last season for the selection of pure strains. There is also a variety series of wheat under culture numbering thirty-one. Most of these came from the seeds of selected heads secured from the 1907 plots.

BARLEY.

The breeding work with this crop has not been undertaken as extensively as with wheat and oats. An attempt is being made to improve a few highly recommended varieties.

OATS.

A part of this selection work was first undertaken by Prof. J. A. Jeffery in 1900, but was turned over to the station in 1907. In addition to this however, last year the station had twenty-three varieties placed in the nursery, followed by sixteen more this year.

A commerical variety is in reality a mixture of several strains, the chances being that some one strain is the prolific yielder, the balance acting merely as fillers. The object therefore is to isolate the prolific strains and reject the others. The process of selection in this case is similar to that heretofore described going back to the individual plant. At present there are one hundred twenty-eight oat breeding plots; sixty-two are from the seed of as many individual plants of last year. There are also seventeen "beds" or plots in the first year and a series of forty-nine one one-hundredths acre plots, fifteen of which trace to single plants in 1906.

FLAX.

The production of flax, especially for the seed product, has been practically dropped and attention concentrated on the fiber flax problems. There are now two hundred forty-nine separate plots of fiber flax mostly produced from seed selected here last year. Only those plots producing the tallest and finest stems will enter into next year's work.

CORN.

The station work in this line includes seven varieties grown in plots in five different counties. In general, the work is that of ear row testing designed to improve the yielding power. Some other corn problems are as follows:

(1). What is the effect, if any, on the progeny from selecting seed from smutted plants.

(2). The result of selection from suckering versus non-suckering plants.

(3). Should seed corn to be planted on clay, sand or loam, be selected from that grown on a similar soil in order to produce the best results.

COWPEAS.

During 1903-5 this station collected numerous varieties of cowpeas for test but most of them proved failures. Last year eighteen varieties selected chiefly for early maturity remained. Of these, four varieties were planted last spring, two of which appear to be promising as one seems to be a profuse seed yielder, the other a great forage producer.

SOY BEANS.

This work started at about the same time as that with cowpeas with similar results. Twenty-eight varieties survived the first culling and of these twenty-one still exist in the one hundred six plots growing on the station at the present time.

ALFALFA.

This has proven a marked success in sections where seed, home grown seed, can be produced for use. Continuous importation of seed prevents acclimation. The primary object of the alfalfa breeding work has been to produce pure strains that will yield seed abundantly and along with large quantities of fodder This work began in 1906 by saving seed from a few scattered plants. In the spring of 1907, this seed was used to start 1760 individual plants, each one grown in a hill by itself; some of these died during the summer and others winter killed. In 1908 there remained 1188 plants from which the first yield of forage was secured, some individuals producing over nine times as much as others. The poor producers were rejected until only 649 large, thrifty, healthy plants remained for comparison and seed production.

This work was extended during the past spring by seed from various parts of the world through the Department of Agriculture. These seeds were started in beds but have just been transferred to the nursery which now contains a total of 4128 plants from 104 different sources.

CLOVER.

The clover and alfalfa problems are somewhat similar. Clover is not seeding as freely in Michigan as it should and pure strains have not been isolated. The nursery now contains 4347 individual plants, the progeny of seeds from eighty-one different sources. Twenty-four of these lots are the progeny of plants which were seeded on the station. As in the case of alfalfa a large number of the seed samples were furnished by the Department of Agriculture from its world wide collection.

TIMOTHY.

From seed kindly furnished by the Experiment Station at Cornell University, New York, we now have 2000 individual plants which will be ready to select from next year. Our object in selection will be to secure plants with more leaf and less stem than is ordinarily found.

R. S. SHAW,
Director.

East Lansing, June 30, 1908.

REPORT OF THE BACTERIOLOGIST.

To R. S. Shaw, Director of the Experiment Station:

The experimental work of this department for the past year has been directed along several lines.

1. The investigations of swine epidemics have been conducted by Mr. C. W. Brown and myself. The results of these investigations are not offered for publication because of their incompleteness. They bear upon work which will be continued this year.

During the month of May, I attended the conference on, and the demonstration of, a treatment for hog cholera, at Ames, Iowa. Dorset's application of Turner and Kolle's method as employed in rinderpest, for the immunization of hogs against hog cholera seems, even at this early date, to be a specific prophylactic. For this, Dorset deserves unstinted praise. At present writing, this department is undertaking to verify the treatment under Michigan conditions, and if it is found as successful as elsewhere, it is hoped that the serum may be made available to the producers of hogs in our state. To this end, the efforts of this department are given.

Mr. Brown's loyal support and faithful service deserve an expression of gratitude.

2. During the past year, Miss Northrup and Miss Farrand have devoted considerable attention to the study of some methods for the determination of bacteria in milk. These studies have their practical import in controlling milk supplies and the measure of purity or cleanliness of milk. Their work is recommended for insertion in this report.

3. It was decided nearly three years ago to undertake the study of the factors involved in the keeping of butter, especially under cold storage conditions. Mr. Wm. Sayer and Dr. Otto Rahn and Miss Bell Farrand have been responsible for all the work done, and are presenting the results at the close of this year for publication. To attack a problem of so great extent and of this nature, it is thought desirable to study many butter samples under conditions which usually exist in cold storage, with the expectation of reaching a comprehensive notion and the more specific facts involved. After this is done, it is hoped to attack the specific problems and determine their influence, one by one. This year's work has been confined to the comprehensive study of the subject. The work for the coming year has already begun in an attack upon some special problems which are indicated by the general work. The direction of this work is under Dr. Rahn, together with C. W. Brown and Miss L. M. Smith.

4. Mr. W. G. Sackett has contributed a bulletin covering some of the investigations of soil bacteria. This work has been conducted in conjunction with our chemist, Mr. A. J. Patten. Chas. W. Brown has also participated in the carrying out of this investigation.

5. Special bulletin No. 42, recently issued, contains results of ex-

tensive investigations on "Bacterial Associations in the Souring of Milk" by Miss Farrand and myself.

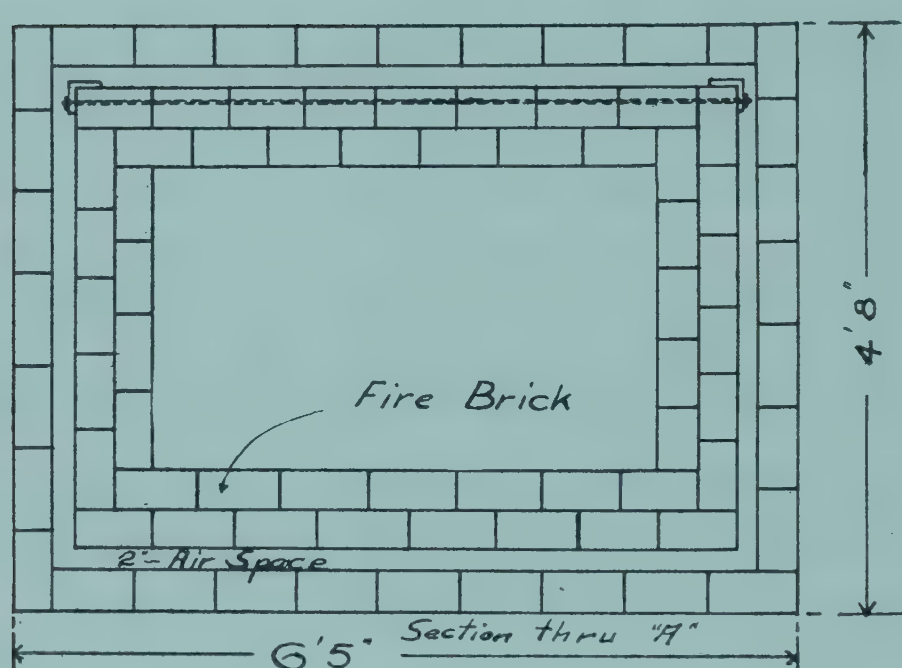
In addition to the above work, we are recommending the publication of several articles which possess a technical nature, and are of interest to investigators only; they may prove of much value to those who are seeking information in these matters.

CHARLES E. MARSHALL,
Bacteriologist.

East Lansing, June 30, 1908.

CREMATING FURNACE.

CHAS. E. MARSHALL.



It has always been a matter of no little concern for this bacteriological laboratory to dispose of its refuse, including infected dead animals. In the past, various means have been employed, but none so successful as the present. Complete combustion of material is desirable and most economical, providing fire can be so applied as to accomplish thorough destruction.

In the use of furnaces, it has been found necessary to either throw the flame down upon the material by forced draft, or submit to the inconvenience experienced by the burning out of grates when the fire is placed below. It has never been our experience to witness cremation in laboratories where it has been successfully accomplished by a flame thrown down from above, or forced draft, unless considerable space is occupied or expense involved. Again when the flame is made to lap down upon surfaces upon which rests the material, considerable force

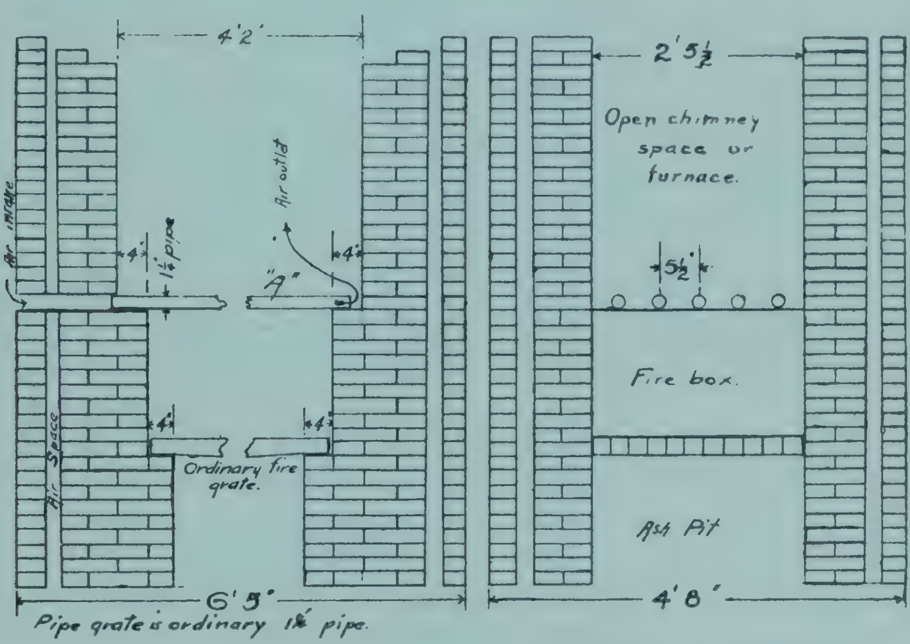
is required to make it feasible. We have, therefore, reached these conclusions concerning furnaces:

1. Where the flame is passed below the material for cremation, the grate burns out so rapidly that the method becomes impracticable.

2. Where the flame is made to lap down from above by forced draft, the cost of construction is excessive.

When our present laboratory was built in 1902, a stack 40 feet high was built with grates, a fire box, and an ash pit; in other words, the furnace consisted of the lower portion of the stack or chimney. The walls of the stack were of solid brick, the inner lining wall consisted of the ordinary sand brick. The grates were the common furnace grates.

After three months of very moderate use, the grates had burned and warped so they were of very little use. Finding that furnishing of grates would be so expensive, we resorted to one means or another

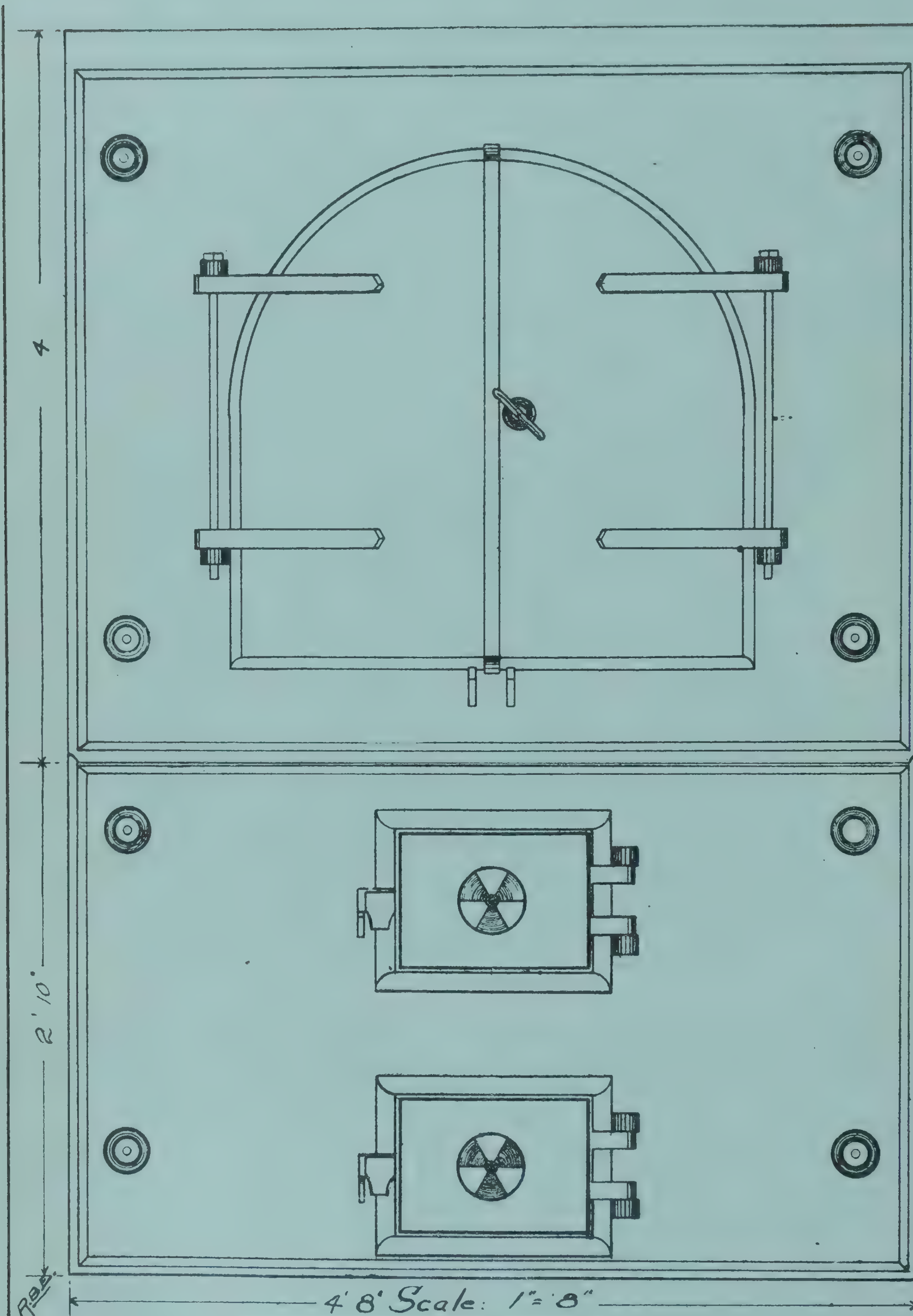


CREMATING FURNACE
BACTERIOLOGICAL DEP'T
MICHIGAN AGRICULTURAL COLLEGE

to support the material and place the fire below. In the fall of 1906, we had occasion to burn a large number of hogs, and, as is well known, the burning of a hog produces intense heat. This resulted in the cracking of the chimney or stack.

A new chimney or stack was ordered, but in the construction of this, the interior lining wall consisted of fire brick and an air space of two inches was introduced between the fire brick and the outside layer of brick. By this construction, it was hoped that the possibility of cracking would be eliminated.

Before completing the work of burning the hogs, the janitor accidentally used a couple of gas pipes to sustain the material in order to place the fire below. It was found after considerable use, that these gas pipes remained intact. It occurred to us at that time that perhaps the gas pipe would furnish a solution of the grate problem; ac-



4'
2' 10"
4' 8" Scale: 1" = 8"
R.B.B.

cordingly, we determined to introduce this feature with some modifications in construction of the new stack. The illustrations which are given contain the details necessary to an understanding. In order to secure the greatest possible advantage in the use of gas pipes, collars have been laid in the walls of the stack, leading from the interior to the exterior. These collars are five in number and consist of two-inch pipe. One and one-fourth inch pipe is used for grating. One end of the pipe used as grating is inserted about an inch into the two-inch pipe collar. The other end rests on a ledge, but remains one or two inches away from the wall. When a fire is built below, the pipes become heated, and cold air is taken from outside, passed through, and out through the flue of the chimney. This has a tendency to keep the pipes cool. Another advantage the pipe has, lies in the failure of the furnace fire to heat the top and bottom of the pipe sufficiently to cause bending. A year ago we placed five one and one-fourth-inch pipes in this stack for the purpose of supporting the material. Today, only one is slightly bent. During the year we have burned a great number of hogs, have burned the bedding used in the stable, have put in this furnace all of the refuse from the laboratory, and it has been used to some extent by other departments on the campus. We feel very well satisfied with the results. A one and one-fourth inch pipe is more easily secured than grates, and costs very much less. If our experience continues in the future as in the past, we shall not have many pipes to provide.

Because of the success of this scheme, I make bold to offer plans for construction to those who have wrestled with this same problem, but have not yet satisfied themselves.

TO PREVENT THE DRYING OF MEDIA.

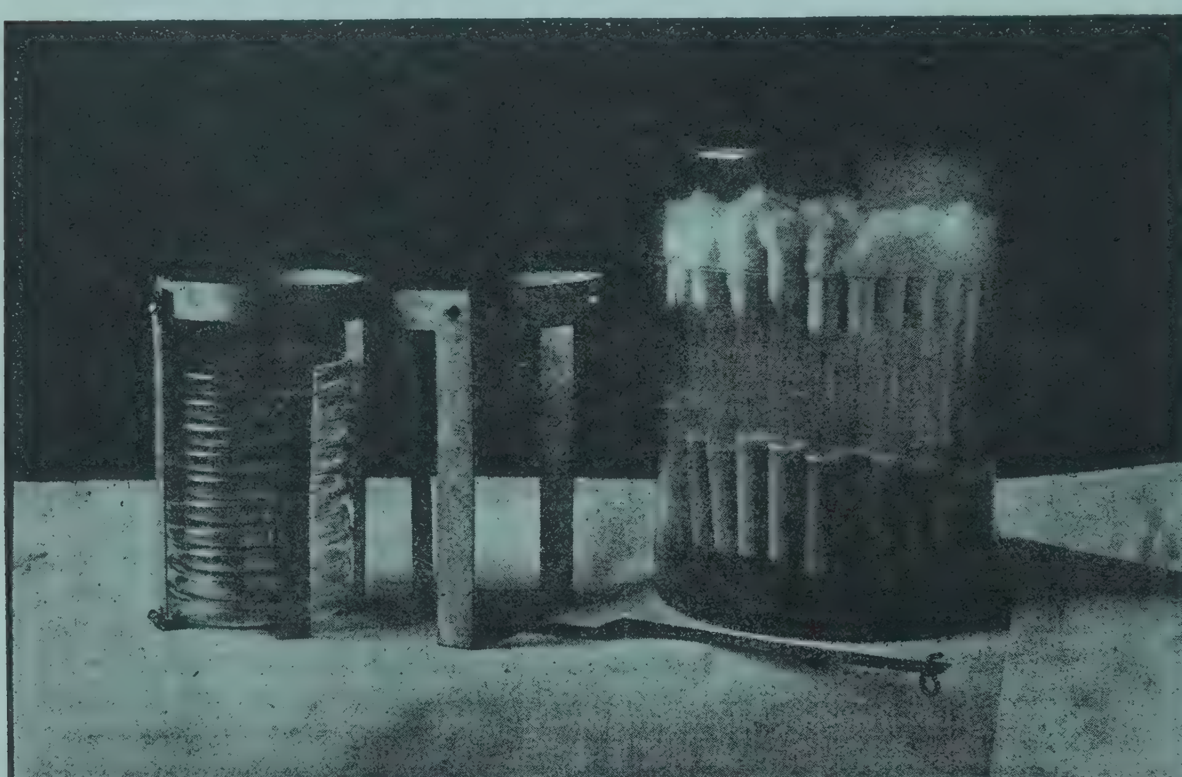
OTTO RAHN.

We keep tubes of media in large glass jars with covers, containing 70-150 test tubes. The bottom of the jar is covered with excelsior (which is more elastic than cotton), and is kept moist by a half per cent mercury bichloride solution, which stands about 1 cm high in the jar.

A CONVENIENT PETRI DISH RACK.

OTTO RAHN.

This rack is shown in the accompanying photograph. I saw these racks at first in the laboratory of Professor Fleischmann in Gottingen, and I believe that the original idea came from Dr. Leichmann. Since I have never seen them in any other laboratory, nor in any catalog, it may be worth while to recommend them for general use, because



they are inexpensive and very handy for keeping and carrying plates. They are made from strips of galvanized sheet iron, and are riveted together to stand the heat of the hot air sterilizer. One of these side strips may be opened by a hinge and may be fastened with a hook. Our racks are 18 cm high and hold 10 dishes.

PREPARATION OF A STANDARD SOLUTION OF LITMUS AND THE MAKING OF LITMUS MEDIA.

CHARLES W. BROWN.

It is known to workers in bacteriology that it is extremely difficult, if not impossible, to make two lots of media of the same composition, and that litmus media are the most subject to variation. Milk which forms a great part of our litmus media is variable in composition at different times even when taken fresh from the same cow. It is the general practice in making litmus media to take a solution of litmus, weak or strong, and add it to the medium until the blue color is of the desired intensity; the litmus solution itself, often composing ten per cent or more of the medium. This method of preparing litmus media is unsatisfactory, first, because it is almost impossible to make two lots of media of the same intensity of blue; second, because different samples of litmus do not contain the same amount of the blue pigment and with solutions varying in strength it is necessary to dilute one lot of media more than another; and, third, because we do not wish to make the difference already existing in the media greater than can be helped by the addition of a stronger or weaker litmus solution, as it interferes materially with the results of bacteriological experiments. In the face of this, it appears to us that more uniform results could be obtained if some way were found by which a standard litmus solution could be made. By adding always the same percentage of the standard solution to our media we would not dilute one lot more than another; again, the finished media of different lots would have a uniform blue color and would be more uniform in composition.

Litmus is a mixture of a lichen dye obtained from the lichens *Roccella* and *Lecanora* by allowing them to ferment after the addition of ammonia and potassium carbonate. When the mass has assumed a deep blue color, the liquid is pressed out, absorbed by chalk or gypsum, and dried. Merck's purified litmus and the sample known in our experiments as "Soluble Litmus" are made from commercial litmus solution by freeing it from the red pigment orcin, which gives commercial litmus the blue violet color, and drying without absorbing it by means of chalk or gypsum. Azolitmin is a purified pigment from litmus.

With the idea that a standard solution of litmus could be prepared, we carried on several experiments with samples of litmus from different sources to determine: first, whether a solution of the same strength could be prepared from the same sample by weighing out portions separately and dissolving them in the same proportion of water; second, whether solutions of the same strength could be made from different samples; and, third, the relation between the solubility of different samples and the relative intensity of their blue color. It was found by experiments that any number of solutions may be made from the same samples by weighing out and dissolving in proportionate volumes of water,

or from different samples, if the relative strength is ascertained by the method described below, which agree with each other within the limits of weights and measures in the intensity of their blue pigment. In other words, a litmus solution equivalent in blue pigment to some standard may be made repeatedly from the same sample or from different samples.

At first we thought of using a solution of some dye, as methylene blue, in preparing a standard, then the idea presented itself that azolitmin, a chemical compound completely soluble in water, could be used as a standard by which to standardize other litmus, or, if desired, may be used in litmus media. The method finally decided upon is as follows: For a standard we sought a solution of such strength that one cubic centimeter when added to one-hundred cubic centimeters of milk would give a blue color to the intensity desired for litmus media, and, after a number of experiments, we found that 2.5 grs. of azolitmin dissolved in one-hundred centimeters of distilled water will give this strength of solution. Using this as a measure, a number of samples of litmus was standardized. Of each sample, a definite amount is weighed out and dissolved in a definite volume of distilled water, either by placing in an incubator at 37.5° C over night or by heating in flowing steam for thirty minutes. The two methods of dissolution gave us the same results. The solution is left to settle, then filtered and the filtrate compared in Nessler's tubes with the standard solution (2.5 grs. azolitmin in 100 cc water) diluted one to five-thousand. By diluting aliquot parts of the filtrate with definite volumes of water, it may be made to correspond very closely to the standard. Distilled water is neutral to litmus and it was found that by adding one or two drops of a decinormal potassium hydrate solution to each Nessler's tube, to make slightly alkaline and to bring out the blue color, duplicate results could be obtained. Calculating from the weight of the sample and the dilutions made, the number of grams required to be dissolved in one hundred cubic centimeters of water to make a solution equivalent in blue pigment to the standard may be determined.

Thirteen samples of litmus were compared with azolitmin as to the intensity of their blue color, giving the numbers recorded in table No. I. The number of grams required to make one hundred cubic centimeters of standard solution is the basis of estimation. The solubilities were also determined for comparison with each other and for ascertaining the relation existing between the solubility and the intensity of the blue pigment. From each sample, a definite amount, approximately one gram, was weighed out and dissolved in about twenty-five cubic centimeters of distilled water by standing over night in an incubator at 37.5°C. The solution was decanted on a filter paper, previously dried and weighed, and more distilled water was added and decanted. This was repeated several times, and finally the residue was transferred to the filter paper and washed with water until the washings were free from blue. The filter paper containing the insoluble residue was dried in an oven at 90° to 100° C to constant weight. The average result, only, of each sample is recorded in Table I.

TABLE NO. I.

Sample.	Grams required to make 100 cc of Standard Solution.	Grams Soluble in 1 gram of Sample.	Per cent Insoluble.
Azolitmin	2.5	1.000	0
Merck's Purified	7.	.977	2.3
Soluble Litmus	8.	.855	14.5
Litmus cubes	140.	.129	87.1
No. 1	15.	.557	44.3
No. 2	32.	.313	68.7
No. 3	68.	.186	81.4
No. 4	98.	.106	89.4
No. 5	128.	.084	91.6
No. 6	164.	.072	92.8
No. 7	110.	.085	91.5
No. 8	154.	.057	94.3
No. 9	146.	.083	91.7
No. 10	122.	.082	91.8

From the experiments we found, as may be seen from the table, that the solubility and the strength of the blue solution correspond closely, although strictly speaking not all that dissolved was coloring matter. At this point, it may be stated that the residue was chiefly calcium carbonate and that the blue solution from the different samples varied in the amount of red pigment they contained. For example, the solutions of azolitmin and the samples marked "litmus cubes," "No. 1" and "No. 2" when slightly alkaline were very near to a true blue, while the others were more or less of a blue violet.

In making a standard solution from any sample of litmus, the number of grams required to make one hundred cubic centimeters of the standard—ascertained by experiment—is placed in a beaker, one hundred cubic centimeters of distilled water added and placed in the incubator over night or in flowing steam for thirty minutes. The insoluble residue is allowed to settle, then the solution is decanted on a filter. The filtrate is the standard solution. However, if it is desired to make a standard solution from a sample that has a large percentage of insoluble material, it is best prepared by adding five hundred cubic centimeters of water instead of one hundred and concentrating the filtrate to one-fifth its volume over a water bath as the residue—if made direct—will retain a large proportion of the solution.

A STUDY OF THE DETERMINATION OF BACTERIA IN MILK IN RELATION TO THE COMPOSITION OF THE MEDIA.*

BY Z. NORTHRUP AND BELL FARRAND.

In order to determine the media most favorable to the growth of germs in milk, different lots of media were prepared to ascertain: 1. the degree of acidity; 2, the percentage of lactose; 3, the percentage of peptone, most conducive to the growth of the milk germs.

For determining the degree of acidity, media were prepared, using 1½% agar, 1% peptone and ½% salt. The agar was digested 20 minutes in the autoclav at 120° C and added to the strained meat infusion containing the peptone and salt. This was titrated to find out the reaction and then divided into four portions, adjusting them to 5°, 10°, 15°, 20° acid respectively, with normal NaOH; counterpoised, heated in flowing steam for 30 minutes, counterpoised again and each portion titrated and the reaction readjusted. Boiled over freely and this was then filtered, tubed (about 10 cc. in each tube), and sterilized for three successive days in flowing steam.

The dilution flasks were prepared as follows: 100 cc of a .06% salt solution was put into 375 cc. Erlenmeyer flasks and sterilized 10 minutes in the autoclav at 120° C.

Each sample of milk was secured in sterile Erlenmeyer flasks, the acidity determined and plates made as soon as reaching the laboratory.

Milk from 0.6 hours old was used for plating. Samples IV to VI and XIV to XX were taken directly from the ten gallon cans in the milk room of the dairy barn. The other samples were obtained at the dairy or from outside sources.

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*This work has been done at the instigation of a "Committee on Standard Methods of Bacterial Milk Analysis," of the American Public Health Association."

SAMPLE III.

4 hours after milking. Dilution 1-100. 15°+.

Acidity of medium.	Germs per CC. 21° C. 2 days.	4 days.	6 days.	8 days.	10 days.	37° C. 24 hours.	48 hours.
5°.......	44720	464480	....	....	....	93360	115280
10°.......	108720	136720	....	....	....	152640	182000
15°.......	164720	151280	....	....	....	158000	160720
20°.......	51280	175280	....	....	....	154640	144000

4 hours after milking. Dilution 1-10,000 15°+.

Acidity of medium.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
5°.......	....	10000	....	....	....	50000	70000
10°.......	....	30000	....	....	....	30000	40000
15°.......	10000	40000	....	....	....	30000	50000
20°.......	10000	30000	....	....	....	no colonies.	

28 hours after milking. Dilution 1-1,000,000. 26°+.

Acidity of medium.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
5°.......	400000	468000	500000	....	....	352000	1040000
10°.......	380000	400000	457000	....	....	140000	593000
15°.......	480000	632000	600000	....	....	287000	746000
20°.......	370000	520000	586000	....	....	168000	334000

SAMPLE IV.

0 hours after milking. Dilution 1-100. 12°+.

Acidity of medium.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
5°.......	325000	600000	735000	810000	712000	283500	300000
10°.......	540000	1050000	1250000	1320000	1120000	900000	1050000
15°.......	749000	1500000	1732000	1850000	1620000	1200000	1410000
20°.......	425000	750000	847000	900000	825000	1050000	1200000

Milk from dairy barn, from ten-gallon can. Milk of one cow.

SAMPLE V.

0 hours after milking. Dilution 1-100. 15°+.

Acidity of medium.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
5°.......	3600	4000	6000	3600	2800	1900	2300
10°.......	5200	5800	7980	5900	5700	6300	8700
15°.......	5400	6000	15540	9300	8100	6800	9100
20°.......	3900	4500	8520	4300	4000	7600	9800

Milk from ten-gallon can at dairy farm.

SAMPLE VI.

0 hours after milking. Dilution 1-100. 16°+.

Acidity of medium.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
5°.......	2600	3500	3800	3400	3700	3600	8000
10°.......	3500	3600	3600	6700	5700	3900	4400
15°.......	3200	5400	5400	8600	10400	6700	12400
20°.......	900	1500	2500	5100	4500	4100	4900

Milk from ten-gallon can at dairy barn. Diminished counts at 8-10 days due to spreaders.

SAMPLE VI.

21 hours after milking. Dilution 1-10,000. 18°+.

Acidity of medium.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
5°.......	59200000	39600000	34716000	44000000	45000000	40000000	66240000
10°.......	66198000	45684000	48798000	49000000	50000000	43550000	80000000
15°.......	82600000	47400000	49500000	51000000	52000000	60600000	64680000
20°.......	27920000	36702000	43200000	44000000	45000000	55000000	63520000

21 hours after milking. Dilution 1-1,000,000. 18°+.

Acidity of medium.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
5°.......	49000000	53000000	51000000	51000000	51000000	39000000	52000000
10°.......	59000000	60000000	63000000	56000000	63000000	53000000	65000000
15°.......	63000000	70000000	71000000	71000000	71000000	57000000	67000000
20°.......	59000000	58000000	60000000	65000000	65000000	51000000	53000000

Milk from ten-gallon can at dairy barn.

SAMPLE VII.

2 hours after milking. Dilution 1-100. 15°+.

Acidity of medium.	Germs per CC.						
	21° C.					37° C.	
	2 days.	4 days.	6 days	8 days.	10 days.	24 hours.	48 hours.
5°.......	257360	262000	250640	195360	227000	602520	616980
10°.......	844000	1051000	834000	592000	623000	706980	796000
15°.......	1183000	1105000	967000	829000	828000	901200	919020
20°.......	853980	987000	619000	609000	617000	754500	864000

2 hours after milking. Dilution 1-10,000. 15°+.

5°.......	150000	350000	450000	510000	960000	790000	1452000
10°.......	880000	1140000	1240000	1060000	1960000	1050000	1902000
15°.......	2100000	2110000	2110000	2010000	3000000	2110000	2550000
20°.......	1590000	1840000	1740000	1600000	2052000	1550000	2250000

Milk from outside source obtained at the dairy. May be more than two hours old.

SAMPLE VIII.

2 (?) hours after milking. Dilution 1-100. 16°+.

5°.......	60000	65000	75000	75000	68520	54000	66000
10°.......	65460	67680	91000	77460	79000	58900	71460
15°.......	71460	84000	76500	78000	91000	78000	85980
20°.......	63350	63000	67000	69000	73500	78000	81360

2 (?) hours after milking. Dilution 1-10,000. 16°+.

5°.......	70000	120000	150000	150000	220000	150000	160000
10°.......	80000	130000	140000	140000	250000	130000	140000
15°.......	100000	160000	190000	190000	290000	160000	200000
20°.......	120000	140000	150000	160000	280000	50000	50000

Mixed night's and morning's milk from vat at the dairy.

SAMPLE IX.

4 to 5 hours after milking. Dilution 1-10,000. 14°+.

5°.......	230000	350000	410000	470000	520000	170000	310000
10°.......	240000	310000	370000	540000	650000	210000	280000
15°.......	260000	390000	460000	540000	650000	320000	510000
20°.......	200000	330000	400000	450000	560000	210000	260000

4 to 5 hours after milking. Dilution 1-1,000,000. 14°+.

5°.......	no colonies.	....	1000000	4000000	8000000	1000000	3000000
10°.......	no colonies.	2000000	7000000	10000000	15000000	* 3000000	3000000
15°	1000000	3000000	6000000	7000000	8000000	2000000	6000000
20°.......	no colonies.	1000000	3000000	12000000	18000000	* no colonies.	

Bulk from milkman. Fat content, 3.80 to 3.85.
* Contamination.

SAMPLE X.

3 to 4 hours after milking. Dilution 1-100. 15°+.

5°.......	66000	90000	91020	95460	97000	78000	96000
10°.......	73500	94500	102000	113500	118000	85540	96000
15°.......	91500	120000	124980	136000	138000	99540	123540
20°.......	78000	78000	87540	90000	92700	80520	94500

3 to 4 hours after milking. Dilution 1-10,000. 15°+.

5°.......	no colonies.	40000	40000	40000	50000	100000	150000
10°.......	70000	150000	150000	160000	190000	110000	120000
15°.......	70000	200000	220000	240000	270000	50000	110000
20°.......	30000	80000	80000	140000	140000	30000	110000

Bottled milk from milk wagon. Fat content, 3.95.

SAMPLE XI

5 to 6 hours after milking. Dilution 1-100. 11°+.

Acidity of medium.	Germs per CC. 21° C. 2 days.	4 days.	6 days.	8 days.	10 days.	37° C. 24 hours.	48 hours.
5°.......	25020	25700	25900	26200	26500	8300	14300
10°.......	20460	24600	25600	27000	27500	10500	15200
15°.......	8700	17400	19200	19800	22000	11200	12200
20°.......	15500	21300	24200	25000	25800	11200	12200

5 to 6 hours after milking. Dilution 1-10,000. 11°+.

Acidity of medium.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
5°.......	20000	20000	20000	20000	20000	20000	110000
10°.......	no colonies.	30000	30000	40000	50000	40000	710000
15°.......	10000	50000	50000	50000	220000	no colonies.	30000
20°.......	no colonies.	10000	20000	20000	30000	10000	40000

Milk from Club C.

SAMPLE XII.

4 to 5 hours after milking. Dilution 1-100. 14°+.

Acidity of medium.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
5°.......	96000	117980	129020	plate broken.	....	75000	111480
10°.......	124000	126500	133340	130980	141540	82000	121500
15°.......	125520	131500	132520	132480	147000	79500	104500
20°.......	145500	149500	153000	148520	169020	91500	93540

4 to 5 hours after milking. Dilution 1-10,000. 14°+.

Acidity of medium.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
5°.......	200000	200000	200000	210000	220000	20000	90000
10°.......	260000	280000	280000	360000	380000	10000	100000
15°.......	210000	210000	210000	220000	220000	60000	110000
20°.......	160000	180000	180000	240000	240000	60000	250000

Milk from Club E.

SAMPLE XIII.

5 to 6 hours after milking. Dilution 1-100. 13°+.

Acidity of medium.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
5°.......	4500	6700	8300	8500	8600	6000	7500
10°.......	6300	11300	11600	12100	12500	8100	10800
15°.......	4500	8700	10300	11500	12000	8200	10600
20°.......	4300	9600	11300	11900	12200	5800	6800

5 to 6 hours after milking. Dilution 1-10,000. 13°+.

Acidity of medium.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
5°.......	no colonies.	....	20000	20000	30000	10000	10000
10°.......	20000	20000	30000	40000	40000	10000	20000
15°.......	no colonies.	20000	30000	30000	50000	20000	30000
20°.......	30000	30000	30000	30000	30000	20000	20000

Milk from Club A

SAMPLE XIV.

0 hours after milking. Dilution 1-100. 15°+.

Acidity of medium.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
5°.......	600	3300	3600	4000	4300	1700	* 1900
10°.......	900	2900	4400	4500	* 4500	2300	* 3400
15°.......	700	3100	4600	4700	* 5500	2000	* 18000
20°.......	600	2800	4300	4400	4300	1900	* 3500

0 hours after milking. Dilution 1-10,000. 15°+.

Acidity of medium.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
5°.......	no colonies.	10000	10000	10000	* 10000	60000	70000
10°.......	30000	170000	290000	360000	* 300000	80000	140000
15°.......	no colonies.	30000	70000	70000	* 80000	220000	330000
20°.......	10000	50000	90000	100000	* 110000	10000	20000

Milk from ten-gallon can at dairy barn.
* Moulds—unaccounted for unless in milk.

SAMPLE XV.

0 hours after milking. Dilution 1-100. 12° +.

Acidity of medium.	Germs per CC.						
	21° C.					37° C.	
	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
5°.......	200	2700	6300	6400	6400	11300	13100
10°.......	1600	6400	9800	9800	9800	10700	12200
15°.......	9400	12400	16000	16200	16200	13200	15600
20°.......	4700	7900	8600	8800	9800	12500	13000

0 hours after milking. Dilution 1-10,000. 12° +.

5°.......	no colonies.	20000	70000	70000	80000	no colonies.	10000
10°.......	10000	30000	40000	40000	40000	no colonies.	....
15°.......	30000	50000	60000	80000	80000	10000	10000
20°.......	10000	10000	10000	10000	20000	30000	40000

Milk from ten-gallon can at dairy barn.

SAMPLE XVI.

0 hours after milking. Dilution 1-100. 13° +.

5°.......	7000	12900	19980	21000	20800	26900	27300
10°.......	7400	15200	21900	22400	22400	28900	29700
15°.......	12000	22500	23800	24900	25000	28600	29800
20°.......	21800	22100	22700	24000	24200	27700	28800

0 hours after milking. Dilution 1-10,000. 13° +.

5°.......	250000	380000	340000	350000	350000	70000	80000
10°.......	50000	520000	410000	410000	410000	70000	70000
15°.......	20000	30000	30000	30000	30000	80000	100000
20°.......	60000	130000	150000	150000	150000	20000	30000

Milk from ten-gallon can at dairy farm.

SAMPLE XVII.

0 hours after milking. Dilution 1-100. 12° +.

5°.......	1100	4800	6300	7600	8000	7900	9200
10°.......	5500	6600	7500	12100	12700	8600	10700
15°.......	11000	12800	13600	14300	14300	8400	14800
20°.......	9000	10300	11400	11400	11400	6200	11300

0 hours after milking. Dilution 1-10,000. 12° +

5°.......	10000	20000	20000	20000	20000	20000	40000
10°.......	no colonies.	20000	20000	30000	30000	20000	30000
15°.......	20000	40000	40000	40000	40000	10000	20000
20°.......	10000	30000	40000	40000	40000	no colonies.	10000

Milk from ten-gallon can at dairy farm.

SAMPLE XVIII.

0 hours after milking. Dilution 1-100. 11° +.

5°.......	300	1000	2900	3300	3300	5300	6800
10°.......	200	1200	2600	3000	* 2600	6000	7400
15°.......	600	1700	3500	4000	4000	4700	7000
20°.......	200	1300	3500	3400	* 3400	5100	6100

0 hours after milking. Dilution 1-10,000. 11° +.

5°.......	20000	140000	160000	180000	180000	no colonies.	....
10°.......	no colonies.	....	....	....	....	10000	20000
15°.......	10000	30000	30000	30000	30000	no colonies.	....
20°.......	10000	10000	20000	30000	30000	30000	30000

Milk from ten-gallon can at dairy barn.
* Moulds mistaken for colonies of bacteria.

SAMPLE XIX.

0 hours after milking. Dilution 1-100. 15°+.

Acidity of medium.	Germs per CC.						
	21° C.					37° C.	
	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
5°.......	2900	3100	3100	3300	3300	6600	7700
10°.......	1900	5600	5100	5200	5300	8100	10400
15°.......	2100	10100	10700	10800	10800	6400	8100
20°.......	1500	9700	9700	9700	10000	4800	7900

0 hours after milking. Dilution 1-10,000. 15°+.

Acidity of medium.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
5°.......	20000	30000	30000	30000	30000	no colonies.	40000
10°.......	no colonies.	40000	60000	60000	60000	20000	30000
15°.......	20000	20000	20000	20000	20000	10000	30000
20°.......	10000	20000	20000	20000	20000	no colonies.	30000

Milk from ten-gallon can at dairy barn.

SAMPLE XX.

0 hours after milking. Dilution 1-100. 13°+.

Acidity of medium.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
5°.......	19200	21540	22520	22700	22700	18700	22500
10°.......	15700	21980	22520	23250	23450	21100	25000
15°.......	23700	24400	25400	25600	25600	19900	25200
20°.......	24000	24980	25000	25200	25200	18000	25600

0 hours after milking. Dilution 1-10,000. 13°+.

Acidity of medium.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
5°.......	30000	30000	40000	40000	40000	no colonies.	40000
10°.......	70000	140000	210000	210000	210000	10000	20000
15°.......	20000	80000	150000	150000	150000	40000	50000
20°.......	40000	90000	160000	160000	160000	30000	60000

Milk from ten-gallon can at dairy barn.
Straight count on all plates of high dilution and good average counts on all others.

ACIDITY—FINAL SUMMARY.

Temperature.	Per cent of Samples Growing Best at			
	+ 5°	+ 10°	+ 15°	+ 20°
21°..	5%	21%	64%	10%
37°..	13%	17%	33%	17%

DETERMINATION OF PER CENT LACTOSE.

To the second lot of media was added the same percentage of agar peptone, and salt as to Lot I. This was adjusted to + 15° * and divided into five portions, to four of which were added 1%, 2%, 3%, and 4% lactose, the fifth being left as ordinary agar.

SAMPLE XXI.

0 hours after milking. Dilution 1-100. 12°+.

Per cent of Lactose.	Germs per CC.						
	21° C.					37° C.	
	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
1%........	121500	139500	144000	180000	184500	136980	146520
2%........	171000	184500	202500	252000	270000	124980	191520
3%........	200500	207000	229500	261000	301500	151980	215520
4%........	226000	240480	274500	274500	315000	166980	304980

0 hours after milking. Dilution 1-10,000. 12°+.

1%........	390000	430000	440000	440000	440000	280000	350000
2%........	190000	190000	190000	190000	190000	160000	160000
3%........	540000	540000	550000	550000	550000	360000	460000
4%........	460000	510000	560000	570000	570000	370000	460000

Milk from Club C.

SAMPLE XXII.

5 hours after milking. Dilution 1-100. 14°+.

1%........	24300	25500	27000	28000	28000	15100	16200
2%........	22100	28000	33000	34000	35000	18500	19000
3%........	27100	30000	33500	34500	35400	17300	18800
4%........	29300	31000	31600	32000	33500	21100	23000

5 hours after milking. Dilution 1-10,000. 14°+.

1%........	150000	121500	139500	144000	144000	20000	30000
2%........	70000	100000	120000	120000	120000	30000	30000
3%........	20000	60000	60000	60000	60000	40000	40000
4%........	no colonies.	60000	60000	70000	70000	180000	180000

Milk from Club A.

SAMPLE XXIII.

6 hours after milking. Dilution 1-100. 14°+.

1%........	121500	126000	130500	135000	135000	22200	23800
2%........	112500	126000	135000	139500	144000	45700	94500
3%........	126000	135000	139500	148500	148500	40300	112500
4%........	117000	135000	153000	157500	162000	24000	126000

6 hours after milking. Dilution 1-10,000. 14°+.

1%........	110000	150000	210000	210000	210000	20000	90000
2%........	130000	240000	270000	270000	270000	20000	160000
3%........	220000	300000	310000	320000	320000	30000	170000
4%........	910000	1080000	1270000	1280000	1280000	30000	180000

Milk from Club E.

SAMPLE XXIV.

2 hours after milking. Dilution 1-100. 16°+.

1%........	4500	4700	5000	5000	5400	2500	5100
2%........	4100	4800	5200	5400	6200	2700	3300
3%........	3800	4100	3700	4000	4200	3100	4900
4%........	3600	4000	3600	4200	4200	1100	2300
OA........	5100	6100	6200	6200	6200	4300	6000

2 hours after milking. Dilution 1-1000. 16°+.

1%........	31000	33000	34000	34000	38000	4000	8000
2%........	4000	4000	5000	5000	5000	6000	10000
3%........	5000	6000	9000	9000	9000	7000	14000
4%........	6000	6000	8000	9000	9000	8000	12000
OA........	16000	19000	22000	28000	28000	3000	5000

Milk from *one* ten-gallon can at the grade barn.

SAMPLE XXV.

3 hours after milking. Dilution 1-100. 14°+.

Per cent of Lactose.	Germs per CC.						
	21° C.					37° C.	
	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
1%.......	3700	3700	4000	4200	4400	2700	3500
2%.......	6700	7400	7600	7700	7700	3800	5000
3%.......	4900	6200	6000	6000	6000	3700	4100
4%.......	4200	4500	4900	4900	4900	3000	3400
OA.......	5700	6500	6500	6700	6700	4300	5900

3 hours after milking. Dilution 1-1000. 14°+.

1%.......	9000	12000	12000	12000	12000	2000	5000
2%.......	4000	5000	5000	5000	5000	3000	6000
3%.......	2000	2000	2000	2000	3000	3000	5000
4%.......	9000	11000	12000	13000	16000	6000	10000
OA.......	10000	12000	12000	12000	12000	5000	7000

Milk from a *second* ten-gallon can at the grade barn.

SAMPLE XXVI.

4 hours after milking. Dilution 1-100. 18°+.

1%.......	15300	16700	17500	17500	17500	4900	7000
2%.......	13500	13800	14100	14500	14500	6800	8600
3%.......	15700	16100	16500	17000	17000	7100	8800
4%.......	8000	8800	12500	12500	12800	9300	11800
OA.......	12200	15200	16000	16000	16000	8900	10600

4 hours after milking. Dilution 1-1000. 18°+.

1%.......	21000	27000	27000	27000	31000	14000	21000
2%.......	20000	22000	22000	22000	28000	15000	20000
3%.......	18000	21000	23000	23000	23000	17000	22000
4%.......	18000	21000	23000	24000	26000	16000	17000
OA.......	8000	17000	23000	23000	23000	5000	10000

Milk from *one* ten-gallon can at the dairy barn.

SAMPLE XXVII.

5 hours after milking. Dilution 1-100. 18°+.

1%.......	22000	22000	22500	23500	23800	8500	11600
2%.......	19200	22000	22000	22000	22500	9100	11800
3%.......	18900	23500	24000	24500	25300	7900	8500
4%.......	18300	25000	25500	26000	26700	11500	19600
OA.......	12500	17500	19000	23000	23000	13500	26300

5 hours after milking. Dilution 1-1000. 18°+.

1%.......	22000	26000	26000	26000	28000	9000	22000
2%.......	19000	20000	20000	20000	20000	5000	6000
3%.......	59000	90000	95000	117000	131000	10000	12000
4%.......	22000	27000	23000	25000	25000	10000	13000
OA.......	10000	12000	14000	25000	26000	11000	15000

Milk from a second ten-gallon can at the dairy barn.

SAMPLE XXVIII.

2 hours after milking. Dilution 1-100. 17°+.

1%.......	7000	10300	13400	13600	13600	3600	3800
2%.......	7500	10700	11700	11700	11700	3400	4300
3%.......	9100	12100	15100	15300	15300	1900	2900
OA.......	8800	12300	15500	16400	16400	counts lost.	....
4%.......	6000	9600	11600	11700	12000	4600	4600

SAMPLE XXVIII.—*Continued.*

2 hours after milking. Dilution 1-1000. 17° +.

Per cent of Lactose.	Germs per CC.						
	21° C.					37° C.	
	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
1%.......	13000	13000	17000	18000	18000	5000	13000
2%.......	9000	13000	18000	22000	23000	7000	10000
3%.......	15000	15000	20000	22000	22000	3000	5000
4%.......	3000	5000	5000	5000	6000	17000	28000
OA.......	6000	8000	8000	9000	9000	780000	990000

Milk from dairy.

SAMPLE XXIX.

3 hours after milking. Dilution 1-500. 15° +.

Per cent of Lactose.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
1%.......	9000	12000	13500	14000	14000	9500	10000
2%.......	7500	12500	14000	15000	15000	11500	14000
3%.......	10000	14500	14500	15500	15500	5000	8500
4%.......	9000	13000	13500	13500	14500	6000	6500
OA.......	2000	6500	7500	11000	11000	13000	14000

3 hours after milking. Dilution 1-1000. 15° +.

Per cent of Lactose.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
1%.......	13000	16000	18000	18000	19000	6000	9000
2%.......	7000	9000	12000	12000	12000	4000	5000
3%.......	14000	16000	16000	19000	19000	8000	15000
4%.......	11000	13000	13000	13000	13000	12000	17000
OA.......	6000	17000	18000	20000	20000	11000	15000

Milk from ten-gallon can at dairy.

SAMPLE XXX.

3 hours after milking. Dilution 1-500. 15° +.

Per cent of Lactose.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
1%.......	56000	57000	58000	58000	58000	41500	44000
2%.......	49500	50500	51500	53000	53500	43000	47500
3%.......	44000	47000	47000	47500	47500	34000	38500
4%.......	41500	42000	42000	43500	44000	41500	48500
OA.......	44500	49500	49500	49500	49500	46500	51000

3 hours after milking. Dilution 1-1000. 15° +.

Per cent of Lactose.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
1%.......	45000	48000	48000	49000	49000	22000	27000
2%.......	46000	51000	51000	51000	51000	45000	46000
3%.......	51000	55000	55000	56000	56000	38000	38000
4%.......	40000	45000	45000	46000	46000	20000	23000
OA.......	58000	65000	65000	66000	66000	50000	53000

Milk from ten-gallon can at grade barn.

SAMPLE XXXI.

3 hours after milking. Dilution 1-500. 15° +.

Per cent of Lactose.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
1%.......	36500	37500	38500	38500	38500	34500	34500
2%.......	34000	44500	45500	45500	45500	12500	13000
3%.......	47000	49500	49500	49500	49500	51000	52000
4%.......	29000	34500	36500	37000	37000	30000	30500
OA.......	20000	27000	33000	33000	33000	22500	23000

3 hours after milking. Dilution 1-1000. 15° +.

Per cent of Lactose.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
1%.......	855000	895000	915000	915000	915000	34000	35000
2%.......	35000	47000	54000	58000	58000	42000	42000
3%.......	41000	50000	55000	65000	67000	42000	48000
4%.......	32000	38000	43000	45000	48000	13000	19000
OA.......	12000	33000	40000	41000	41000	10000	19000

Milk from dairy.

SAMPLE XXXII.

3 hours after milking. Dilution 1-500. 16°+.

Per cent of Lactose.	Germs per CC.						
	21° C.					37° C.	
	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
1%.......	16000	18000	22000	22000	225000	21000	21000
2%.......	17500	18000	18500	24000	24000	18500	21500
3%.......	18000	20000	20000	20000	20000	5500	6500
4%.......	19500	24500	24500	24500	25500	5000	7000
OA.......	6000	15000	15500	17500	19500	14500	17500

3 hours after milking. Dilution 1-1000. 16°+.

Per cent of Lactose.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
1%.......	24000	27000	31000	31000	38000	20000	20000
2%.......	7000	8000	8000	9000	10000	38000	46000
3%.......	15000	22000	22000	22000	25000	10000	16000
4%.......	14000	23000	23000	23000	26000	13000	15000
OA.......	8000	27000	34000	34000	34000	10000	15000

Milk from dairy.

SAMPLE XXXIII.

3 hours after milking. Dilution 1-500. 14°+.

Per cent of Lactose.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
1%.......	44500	50500	51000	51000	54000	28000	38500
2%.......	38000	50000	51500	51500	55000	12000	15000
3%.......	33500	44500	45500	48500	48500	24500	30500
4%.......	32500	40000	41000	41000	41000	20500	27000
OA.......	13000	33000	34500	39000	39500	24000	24500

3 hours after milking. Dilution 1-1000. 14°+.

Per cent of Lactose.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
1%.......	35000	44000	45000	45000	45000	32000	35000
2%.......	36000	46000	52000	55000	58000	24000	32000
3%.......	46000	62500	64000	65000	67000	22000	24000
4%.......	341000	365000	430000	450000	460000	34000	41000
OA.......	15000	40000	41000	42000	42000	22000	29000

Milk from dairy. Sticks and dirt in flask.

SAMPLE XXXIV.

3 hours after milking. Dilution 1-500. 14°+.

Per cent of Lactose.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
1%.......	22000	36500	38000	41500	41500	4000	5000
2%.......	21000	31500	32000	33500	33500	10500	14000
3%.......	22500	33000	33000	33000	33000	10000	10000
4%.......	20500	31000	31500	31500	31500	5000	7500
OA.......	19000	25000	26000	26000	26000	counts lost.	....

3 hours after milking. Dilution 1-1000. 14°+.

Per cent of Lactose.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
1%.......	13000	22000	25000	26000	26000	12000	18000
2%.......	18000	29000	29000	30000	30000	12000	15000
3%.......	14000	23000	24000	24000	24000	13000	16000
4%.......	5000	19000	20000	21000	21000	8000	10000
OA.......	15000	23000	23000	23000	24000	3000	7000

Milk from dairy.

SAMPLE XXXV.

3 hours after milking. Dilution 1-500. 16°+.

Per cent of Lactose.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
1%.......	33500	39000	39500	39500	39500	15500	19500
2%.......	25000	32000	33500	33500	33500	18000	22000
3%.......	39000	41500	41500	41500	41500	8500	16000
4%.......	25000	25500	26500	26500	26500	7000	10000
OA.......	11500	19000	21500	22000	23500	6000	9000

SAMPLE XXV.—*Continued.*

3 hours after milking. Dilution 1-1000. 16°+.

Per cent of Lactose.	Germs per CC.						
	21° C.					37° C.	
	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
1%.......	42000	45000	45000	46000	46000	19000	31000
2%.......	41000	47000	49000	51000	54000	36000	48000
3%.......	23000	25000	25000	25000	25000	19000	29000
4%.......	33000	46000	46000	53000	53000	35000	35000
OA.......	37000	38000	38000	38000	38000	28000	29000

Milk from dairy.

SAMPLE XXXVI.

3 hours after milking. Dilution 1-500. 15°+.

1%.......	14500	22500	22500	24500	25000	8000	11000
2%.......	19000	28000	28500	28500	28500	9500	13500
3%.......	20500	33500	34500	35500	35500	10000	11500
4%.......	27000	37000	40500	40500	40500	17000	20000
OA.......	9000	21500	24500	27000	27000	11000	13500

3 hours after milking. Dilution 1-1000. 15°+.

1%.......	21000	30000	32000	33000	33000	14000	14000
2%.......	22000	32000	35000	35000	35000	14000	14000
3%.......	16000	31000	32000	32000	34000	15000	18000
4%.......	21000	33000	35000	37000	37000	13000	16000
OA.......	18000	28000	34000	35000	35000	12000	14000

Milk from dairy. Used another lot of 4% lactose agar for this sample.

SAMPLE XXXVII.

3 hours after milking. Dilution 1-500. 16°+.

1%.......	16500	24000	26500	31000	31000	11500	11500
2%.......	12000	17000	21500	22500	22500	11500	13500
3%.......	17000	26000	28000	30000	30000	15500	15500
4%.......	15500	25000	28000	28500	28500	11500	12500
OA.......	17000	31000	39500	44000	44000	11000	15500

3 hours after milking. Dilution 1-1000. 16°+.

1%.......	25000	40000	41000	41000	41000	18000	23000
2%.......	21000	31000	34000	35000	35000	18000	24000
3%.......	19000	42000	42000	46000	46000	21000	21000
4%.......	34000	50000	50000	50000	50000	34000	34000
OA.......	11000	24000	26000	27000	27000	10000	11000

Milk from dairy.

SAMPLE XXXVIII.

3 hours after milking. Dilution 1-500. 15°+.

1%.......	14000	18000	19500	19500	19500	15500	18000
2%.......	21000	25000	27000	27000	29000	13500	17500
3%.......	15000	19500	21500	22500	22500	18000	19000
4%.......	17000	22500	24000	24500	24500	17000	18000
OA.......	3000	135000	18000	195000	20500	13500	16500

3 hours after milking. Dilution 1-1000. 15°+.

1%.......	12000	19000	19000	21000	21000	18000	23000
2%.......	13000	19000	23000	23000	24000	17000	17000
3%.......	21000	26000	28000	28000	28000	19000	20000
4%.......	17000	21000	23000	24000	24000	15000	16000
OA.......	13000	21000	26000	29000	31000	14000	15000

Milk from dairy.

SAMPLE XXXIX.

3 hours after milking. Dilution 1-500. 16° +.

Per cent of Lactose.	Germs per CC. 21° C. 2 days.	4 days.	6 days.	8 days.	10 days.	37° C. 24 hours.	48 hours.
1%.......	27500	33500	35000	35000	35000	18000	20500
2%.......	18000	25000	26500	28500	29000	22000	23500
3%.......	23000	32500	32500	32500	32500	18500	22000
4%.......	21500	28500	28500	29500	30000	11500	16000
OA.......	5500	11500	19500	25500	27500	9000	12500
	3 hours after milking. Dilution 1-1000. 16° +.						
1%.......	23000	24000	24000	24000	24000	14000	16000
2%.......	35000	43000	43000	55000	56000	23000	25000
3%.......	19000	30000	31000	33000	34000	18000	23000
4%.......	33000	33000	33000	33000	33000	26000	31000
OA.......	19000	30000	33000	33000	33000	17000	21000

Milk from dairy.

LACTOSE—FINAL SUMMARY.

Temperatures.	Per cent of samples growing best in 0%	1%	2%	3%	4%
21° C.	15%	27%	22%	15%	21%
37° C.	20%	10%	17.5%	17.5%	35%

AFTER SUMMARY.

From the above summary, it is noted that the milk germs grow be on 1% lactose agar at 21° C. and on 4% lactose agar at 37° C.

DETERMINATION OF PER CENT OF PEPTONE.

To the third lot of media was added 1% lactose, and the same pe centage of agar and salt as to Lots I and II. Lot III was divid into three portions; to the 1st and 2nd were added 1% and 3% pepto respectively, the 3rd portion left without peptone.

SAMPLE LIV.

3 hours after milking. Dilution 1-500. 15°+.

Per cent of Peptone.	Germs per CC. 21° C. 2 days.	21° C. 4 days.	21° C. 6 days.	21° C. 8 days.	21° C. 10 days.	37° C. 24 hours.	37° C. 48 hours.
1%.......	182500	184500	200000	200000	200000	131000	132500
2%.......	66500	67500	81000	83500	84000	30500	36000
3%.......	177500	179500	182500	187500	187500	125000	125000

3 hours after milking. Dilution 1-1000. 15°+.

%.......	116000	121000	132000	133000	133000	154000	169000
%.......	116000	128000	146000	146000	146000	66000	69000
%.......	121000	123000	137000	138000	138000	151000	153000

Milk from dairy, 4-29-08.

SAMPLE LV.

3 hours after milking. Dilution 1-500. 15°+.

%.......	59500	168500	212500	232500	232500	217500	227500
%.......	48500	135000	147500	147500	147500	82500	82500
%.......	52000	186500	187500	192500	195000	155000	162500

3 hours after milking. Dilution 1-1000. 15°+.

%.......	34000	61000	110000	150000	161000	139000	204000
%.......	11000	18000	20000	38000	45000	36000	82000
%.......	62000	215000	220000	231000	235000	152000	160000

Milk from grade barn, 4-30-08.

SAMPLE LVI.

3 hours after milking. Dilution 1-500. 15°+.

%.......	34500	45500	46000	46000	46000	72500	73000
%.......	95500	119000	142500	152500	167500	70000	77500
%.......	85500	98500	110000	117500	150000	122500	130000

3 hours after milking. Dilution 1-1000. 15°+.

%.......	27000	32000	44000	45000	45000	73000	88000
%.......	85000	118000	124000	126000	126000	56000	64000
%.......	97000	128000	128000	128000	128000	119000	128000

Milk from dairy barn, 4-30-08.

SAMPLE LVII.

3 hours after milking. Dilution 1-1000. 15°+.

%.......	6000	44000	49000	50000	5000	15000	35000
%.......	5000	10000	11000	40000	40000	3000	37000
%.......	51000	59000	61000	62000	62000	60000	63000

3 hours after milking. Dilution 1-5000. 15°+.

%.......	5000	55000	55000	65000	65000	50000	50000
%.......	10000	10000	20000	45000	60000	10000	40000
%.......	45000	65000	70000	80000	850000	45000	45000

Milk from dairy barn 5-4-08.

SAMPLE LVIII.

3 hours after milking. Dilution 1-1000. 15°+.

%.......	1000	8000	8000	11000	11000	5000	7000
....	no colonies.	10000	10000	10000	11000	11000	16000
....	6000	26000	27000	27000	27000	25000	32000

SAMPLE LVIII.—*Continued.*

3 hours after milking. Dilution 1-5000. 15°+.

Per cent of Peptone.	Germs per CC.						
	21° C.					37° C.	
	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
1%.......	no colonies.	....	....	....	....	10000	10000
1%.......	no colonies.	....	....	....	....	15000	15000
3%.......	no colonies.	40000	45000	50000	50000	45000	55000

Milk from grade barn, 5-5-08.

SAMPLE LIX.

3 hours after milking. Dilution 1-1000. 15°+.

0%.......	no colonies.	....	1000	2000	2000	11000	13000
1%.......	2000	5000	5000	6000	6000	10000	11000
3%.......	13000	28000	42000	43000	43000	9000	12000

3 hours after milking. Dilution 1-5000. 15°+.

0%.......	no colonies.	....	10000	20000	20000	5000	5000
1%.......	5000	10000	10000	15000	15000	no colonies.	5000
3%.......	10000	35000	35000	40000	45000	35000	40000

Milk from dairy barn, 5-5-08.

SAMPLE LX.

3 hours after milking. Dilution 1-1000. 14°+.

0%.......	12000	23000	117000	167000	176000	16000	332000
1%.......	5000	11000	13000	15000	17000	14000	202000
3%.......	320000	330000	338000	345000	375000	157500	348000

3 hours after milking. Dilution 1-5000. 14°+.

0%.......	15000	35000	50000	50000	50000	no colonies.	280000
1%.......	15000	20000	35000	35000	35000	15000	220000
3%.......	265000	265000	370000	370000	370000	470000	480000

Milk from grade barn, 5-6-08.

SAMPLE LXI.

3 hours after milking. Dilution 1-1000. 15°+.

0%.......	5000	15000	24000	27000	28000	66000	104000
1%.......	5000	28000	39000	45000	48000	14000	49000
3%.......	98000	132000	159000	141000	143000	102000	102000

3 hours after milking. Dilution 1-5000. 15°+.

0%.......	20000	60000	145000	155000	155000	135000	145000
1%.......	15000	30000	60000	80000	85000	40000	65000
3%.......	60000	95000	95000	95000	95000	185000	195000

Milk from dairy barn, 5-6-08.

SAMPLE LXII.

3 hours after milking. Dilution 1-1000. 14°+.

0%.......	1000	1000	5000	5000	5000	8000	11000
1%.......	4000	8000	16000	21000	25000	8000	13000
3%.......	18000	19000	22000	22000	23000	16000	18000

3 hours after milking. Dilution 1-5000. 14°+.

0%.......	10000	10000	10000	10000	10000	15000	25000
1%.......	no colonies.	5000	10000	10000	10000	10000	15000
3%.......	20000	25000	35000	35000	35000	5000	10000

Milk from grade barn, 5-7-08.

SAMPLE LXIII.

3 hours after milking. Dilution 1-1000. 15°+.

Per cent of Peptone.	Germs per CC.						
	21° C.					37° C.	
	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
0%.......	8000	15000	32000	35000	36000	11000	20000
1%.......	4000	11000	16000	21000	27000	5000	21000
3%.......	12000	29000	31000	36000	37000	14000	17000

3 hours after milking. Dilution 1-5000. 15°+.

0%.......	5000	5000	30000	30000	30000	no colonies.	15000
1%.......	no colonies.	....	....	....	5000	5000	30000
3%.......	15000	35000	50000	50000	50000	25000	30000

Milk from dairy barn, 5-7-08.

SAMPLE LXIV.

3 hours after milking. Dilution 1-1000. 14°+.

0%.......	4000	9000	39000	48000	52000	21000	57000
1%.......	3000	8000	19000	26000	29000	7000	33000
3%.......	46000	70000	70000	70000	70000	53000	64000

3 hours after milking. Dilution 1-5000. 14°+.

0%.......	30000	60000	100000	120000	125000	30000	65000
1%.......	no colonies.	10000	15000	20000	35000	no colonies.	5000
3%.......	25000	40000	40000	40000	40000	45000	50000

Milk from grade barn, 5-8-08.

SAMPLE LXV.

3 hours after milking. Dilution 1-1000. 15°+.

0%.......	26000	62000	62000	62000	70000	12000	17000
1%.......	20000	37000	58000	65000	81000	17000	22000
3%.......	87000	105000	106000	10700	111000	86000	88000

3 hours after milking. Dilution 1-5000. 15°+.

0%.......	10000	30000	30000	35000	40000	5000	15000
1%.......	5000	5000	15000	20000	25000	20000	30000
3%.......	65000	85000	85000	85000	90000	125000	130000

Milk from dairy barn, 5-8-08.

SAMPLE LXVI.

3 hours after milking. Dilution 1-1000. 14°+.

0%.......	3000	6000	9000	9000	9000	3000	6000
1%.......	no colonies.	1000	2000	4000	5000	2000	7000
3%.......	3000	7000	7000	7000	7000	10000	12000

3 hours after milking. Dilution 1-5000. 14°+.

0%.......	no colonies.	5000	5000	15000	20000	5000	5000
1%.......	no colonies.	10000	10000	10000	15000	10000	10000
3%.......	no colonies.	15000	15000	15000	15000	10000	30000

Milk from grade barn, 5-9-08.

SAMPLE LXVII.

3 hours after milking. Dilution 1-1,000. 16°+.

0%.......	9000	15000	18000	18000	25000	14000	19000
1%.......	8000	16000	20000	22000	23000	7000	13000
3%.......	18000	25000	34000	35000	39000	36000	47000

SAMPLE LXVII.—*Continued.*

3 hours after milking. Dilution 1-5000. 16°+.

Per cent of Peptone.	Germs per CC.						
	21° C.					37° C.	
	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
0%.......	no colonies.	broken.	....	....	....	15000	15000
1%.......	no colonies.	20000	20000	20000	20000	5000	20000
3%.......	35000	50000	55000	55000	55000	30000	35000

Milk from dairy barn, 5-9-08.

SAMPLE LXVIII.

3 hours after milking. Dilution 1-1000. 16°+.

0%.......	4000	5000	6000	27000	30000	41000	53000
1%.......	no colonies.	....	2000	2000	2000	3000	13000
3%.......	36000	48000	55000	56000	56000	38000	51000

3 hours after milking. Dilution 1-5000. 16°+.

0%.......	no colonies.	....	....	....	5000	30000	35000
1%.......	no colonies.	10000	15000	15000	15000	10000	30000
3%.......	15000	25000	40000	40000	40000	50000	50000

Milk from grade barn, 5-11-08.

SAMPLE LXIX.

3 hours after milking. Dilution 1-1000. 16°+.

0%.......	3000	7000	8000	13000	16000	6000	6000
1%.......	1000	4000	4000	5000	6000	2000	2000
3%.......	21000	26000	27000	30000	30000	12000	16000

3 hours after milking. Dilution 1-5000. 16°+.

0%.......	5000	15000	25000	35000	45000	15000	35000
1%.......	no colonies.	15000	15000	25000	30000	20000	30000
3%.......	20000	35000	50000	50000	50000	55000	55000

Milk from dairy barn, 5-11-08.
Last of first lot of Peptone media.

SAMPLE LXX.

4 hours after milking. Dilution 1-1000. 14°+.

0%.......	5000	27000	33000	35000	35000	10000	16000
1%.......	9000	36000	37000	48000	53000	10000	15000
3%.......	13000	17000	26000	26000	26000	13000	16000

4 hours after milking. Dilution 1-5000. 14°+.

0%.......	20000	50000	60000	60000	60000	30000	30000
1%.......	10000	30000	30000	30000	30000	20000	25000
3%.......	10000	10000	25000	25000	25000	5000	10000

Milk from grade barn, 5-19-08.

SAMPLE LXXI.

4 hours after milking. Dilution 1-1000. 15°+.

0%.......	56000	122000	127000	127000	127000	60000	93000
1%.......	61000	114000	119000	119000	119000	74000	87000
3%.......	99000	105000	105000	105000	105000	88000	93000

4 hours after milking. Dilution 1-5000. 15°+.

0%.......	60000	150000	155000	155000	165000	90000	100000
1%.......	55000	150000	150000	150000	150000	145000	160000
3%.......	105000	130000	130000	130000	135000	105000	130000

Milk from dairy barn, 5-19-08.

SAMPLE LXXII.

3 hours after milking. Dilution 1-1000. 14°+.

Per cent of Peptone.	Germs per CC.						
	21° C.					37° C.	
	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
0%	18000	40000	42000	44000	44000	44000	44000
1%	22000	44000	50000	50000	53000	47000	52000
3%	43000	54000	54000	54000	54000	26000	53000
3 hours after milking. Dilution 1-5000. 14°+.							
0%	45000	50000	50000	50000	50000	50000	50000
1%	20000	70000	70000	75000	75000	45000	70000
3%	35000	40000	45000	45000	45000	40000	75000

Milk from dairy barn, 5-21-08.

SAMPLE LXXIII.

3 hours after milking. Dilution 1-1000. 14°+.

0%	126000	149000	159000	159000	159000	70000	90000
1%	119000	143000	145000	150000	150000	86000	87000
3%	113000	117000	117000	117000	117000	83000	85000
3 hours after milking. Dilution 1-5000. 14°+.							
0%	130000	185000	215000	220000	225000	100000	130000
1%	110000	135000	135000	135000	135000	115000	120000
3%	120000	135000	145000	145000	145000	75000	100000

Milk from grade barn, 5-21-08.

SAMPLE LXXIV.

4 hours after milking. Dilution 1-1000. 17°+.

0%	50000	50000	53000	53000	54000	18000	27000
1%	42000	43000	43000	44000	44000	23000	39000
3%	48000	48000	49000	49000	49000	39000	44000
4 hours after milking. Dilution 1-5000. 17°+.							
0%	55000	60000	60000	60000	60000	65000	80000
1%	45000	45000	60000	60000	65000	55000	65000
3%	50000	55000	55000	55000	55000	30000	40000

Milk from grade barn, 5-22-08.

SAMPLE LXXV.

4 hours after milking. Dilution 1-1000. 15°+.

0%	139000	140000	142000	142000	142000	111000	117000
1%	134000	140000	146000	153000	153000	11400	125000
3%	132000	132000	135000	137000	139000	121000	128000
4 hours after milking. Dilution 1-5000. 15°+.							
0%	120000	155000	160000	165000	165000	80000	90000
1%	155000	175000	195000	195000	195000	125000	150000
3%	115000	125000	125000	125000	125000	130000	135000

Milk from dairy barn, 5-22-08.

SAMPLE LXXVI.

5 hours after milking. Dilution 1-1000. 11°+.

0%	43000	48000	52000	53000	53000	85000	88000
1%	55000	118000	129000	130000	134000	84000	87000
3%	88000	90000	92000	92000	92000	72000	90000

SAMPLE LXXVI.—*Continued.*

5 hours after milking. Dilution 1-5000. 11°+.

Per cent of Peptone.	Germs per CC. 21° C. 2 days.	4 days.	6 days.	8 days.	10 days.	37° C. 24 hours.	48 hours.
0%.......	45000	60000	70000	75000	80000	80000	90000
1%.......	40000	120000	125000	125000	125000	95000	100000
3%.......	105000	125000	125000	125000	125000	150000	155000

Separated cream from dairy, 5-28-08.

SAMPLE LXXVII.

3 hours after milking. Dilution 1-1000. 13°+.

Per cent of Peptone.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
0%.......	19000	40000	44000	44000	44000	20000	35000
1%.......	22000	24000	25000	26000	26000	15000	20000
3%.......	13000	23000	32000	34000	35000	11000	23000

3 hours after milking. Dilution 1-5000. 13°+.

Per cent of Peptone.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
0%.......	15000	contaminated	....	....	....	10000	15000
1%.......	15000	25000	30000	35000	35000	15000	40000
3%.......	5000	10000	10000	20000	25000	10000	45000

Milk from grade barn, 6-1-08.

SAMPLE LXXVIII.

3 hours after milking. Dilution 1-1000. 14°+.

Per cent of Peptone.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
0%.......	36000	49000	56000	58000	59000	42000	61000
1%.......	34000	40000	40000	40000	40000	35000	43000
3%.......	41000	65000	65000	65000	65000	25000	37000

3 hours after milking. Dilution 1-5000. 14°+.

Per cent of Peptone.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
0%.......	25000	40000	45000	45000	45000	50000	60000
1%.......	25000	55000	60000	60000	65000	45000	55000
3%.......	50000	65000	70000	70000	70000	55000	65000

Milk from dairy barn, 6-1-08.

SAMPLE LXXIX.

3 hours after milking. Dilution 1-1000. 15°+.

Per cent of Peptone.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
0%.......	6000	15000	15000	16000	16000	11000	11000
1%.......	15000	27000	32000	32000	32000	16000	17000
3%.......	6000	20000	23000	23000	23000	12000	13000

3 hours after milking. Dilution 1-5000. 15°+.

Per cent of Peptone.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
0%.......	10000	30000	30000	45000	50000	15000	20000
1%.......	40000	55000	65000	70000	75000	25000	35000
3%.......	no colonies	25000	30000	35000	35000	15000	15000

Milk from grade barn, 6-2-08.

SAMPLE LXXX.

3 hours after milking. Dilution 1-1000. 13°+.

Per cent of Peptone.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
0%.......	7000	8000	8000	8000	8000	14000	14000
1%.......	11000	20000	25000	27000	28000	13000	13000
3%.......	2000	6000	11000	11000	11000	13000	17000

3 hours after milking. Dilution 1-5000. 13°+.

Per cent of Peptone.	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
0%.......	25000	50000	50000	55000	55000	20000	30000
1%.......	35000	40000	50000	55000	55000	45000	45000
3%.......	5000	15000	30000	30000	30000	20000	35000

Milk from dairy barn, 6-2-08.

SAMPLE LXXXI.

3 hours after milking. Dilution 1-1000. 14°+.

Per cent of Peptone.	Germs per CC.						
	21° C.					37° C.	
	2 days.	4 days.	6 days.	8 days.	10 days.	24 hours.	48 hours.
0%.......	15000	19000	20000	21000	22000	15000	17000
1%.......	12000	23000	23000	23000	23000	27000	28000
3%.......	11000	34000	34000	34000	34000	16000	21000
3 hours after milking. Dilution 1-5000. 14°+.							
0%.......	15000	35000	35000	35000	35000	20000	30000
1%.......	15000	25000	25000	25000	25000	20000	20000
3%.......	no colonies....	25000	25000	25000	25000	no colonies.	

Milk from dairy barn, 6-3-08. Last of new media.

PEPTONE—FINAL SUMMARY.

Temperature.	Per cent of samples growing best in			
	0%	1%	3%	
21° C..........	22%	6%	72%	First lot.
37° C..........	27%	6⅓%	66⅔%	First lot.
21° C..........	35%	38%	27%	Second lot.
37° C..........	35%	23%	42%	Second lot.

FINAL SUMMARY OF TEMPERATURE.

Per cent of samples growing best at		
21° C.	37° C.	Indeterminate.
63%	9%	28%

FINAL SUMMARY OF ACIDITY, LACTOSE AND PEPTONE MEDIA.

		Temperature.	
		21° C.	37° C.
Acidity..........	5°....	5%	13%
	10°...	21%	17%
	15°...	64%	33%
	20°...	10%	17%
Per cent of Lactose..........	0%...	15%	20%
	1%...	27%	10%
	2%...	22%	17½%
	3%...	15%	17½%
	4%...	21%	35%
Per cent of Peptone—First lot..........	0%...	22%	27%
	1%...	6%	6⅓%
	3%...	72%	66⅔%
Per cent of Peptone—Second lot..........	0%...	35%	35%
	1%...	38%	23%
	3%...	27%	42%

COMPARISON OF THE GROWTH OF DAIRY GERMS ON WHEY, ORDINARY AND 4% LACTOSE AGAR.

To check up the results obtained by plating the miscellaneous milk organisms, pure cultures of dairy germs (taken from butter), were grown on whey, ordinary and 4% lactose agar.

Four per cent lactose agar was used in this experiment as it was found to support the growth of the milk germs better than the ordinary (1%) lactose agar, at 37° C. The explanation for this is that the media, in the per cent of lactose, reaches more nearly the composition of milk.

All media was made according to standard methods, and adjusted to 15° acid.

Each germ was plated in three series and special care was taken to have like conditions for comparisons.

METHOD.

1. Agar streak cultures of each germ, 3 days old were used for making transfers.
2. The 3 day culture was transferred to a broth tube and grown 48 hours.
3. A loop transfer from (2) was made into 50 cc. of broth and grown 24 hours at 22° C.
4. With a sterile pipette, 1 cc. of the 24 hour broth suspension was transferred into a 99 cc. dilution flask. (.06% salt solution.)

Dilutions 1-1,000, 1-10,000, 1-100,000, 1-1,000,000, and 1-10,000,000 were made.

5. Each germ was plated on the different media from the last four dilutions.
6. Plates were kept 7 days at 22° C. and counts recorded.

COMPARISON OF THE GROWTH OF DAIRY GERMS, ETC.

The germs D-L, A-S, VI c A, and IV c B, are of the lactic acid type. The other germs, III b G, IV b D, III b C, VIII b E, and VIII b A are associative germs in milk and other dairy products.

The counts are recorded as number of germs per plate.

SEVEN DAY COUNTS ON PURE CULTURES OF GERMS TAKEN FROM BUTTER.

Media—Whey, Ordinary and 4% Lactose Agar.

Germ.	Media.	Dilutions.			
		10,000.	100,000.	1,000,000.	10,000,000.
D-L (lactic)	Ordinary	15,300	2,150	241	
	Whey	17,100	1,700	196	[illegible]
	Lactose	15,300	1,000	256	[illegible]
A-S (lactic)	Ordinary	2,400	251	36	
	Whey	2,250	295	21	
	Lactose	2,000	214	30	
III b G	Ordinary	19	1	.....	.....
	Whey	8	.....	.....	.....
	Lactose	200	.....	.....	
IV b D	Ordinary	1,472	87	22	.....
	Whey	950	23	12	.....
	Lactose	1,750	100	12	
III b C	Ordinary	1,700	276	39	.....
	Whey	2,600	contamination	contamination	.....
	Lactose	2,200	256	38	.....
VIII b E	Ordinary	100	82	1	.....
	Whey	.....	.....	.....	.....
	Lactose	.....	.....	.....	.....
D-L (lactic)	Ordinary	13,731	1,782	222	[illegible]
	Whey	13,134	1,980	Lost	[illegible]
	Lactose	15,522	2,442	215	[illegible]
A-S (lactic)	Ordinary	1,782	178	6	
	Whey	1,914	208	22	
	Lactose	1,452	172	20	
III b G	Ordinary	1	.....	.....	.....
	Whey	1	.....	.....	.....
	Lactose	.....	.....	.....	.....
IV b D	Ordinary	8,955	1,122	121	[illegible]
	Whey	14,925	858	117	[illegible]
	Lactose	13,134	1,452	240	[illegible]
III b C	Ordinary	1,188	152	14	
	Whey	682	45	.....	.....
	Lactose	1,386	268	12	.....
VIII b E	Ordinary	.....	1	.....	.....
	Whey	.....	.....	.....	.....
	Lactose	.....	.....	.....	.....
D-L (lactic)	Ordinary	16,716	1,188	197	[illegible]
	Whey	15,522	330	185	[illegible]
	Lactose	14,328	1,056	194	[illegible]
A-S (lactic)	Ordinary	2,508	55	34	contaminatio
	Whey	1,980	215	29	
	Lactose	2,442	78	12	contaminatio
III b G	Ordinary	23	.....	.....	.....
	Whey	3	.....	.....	.....
	Lactose	.....	.....	.....	.....
IV b D	Ordinary	1,124	72	12	
	Whey	3,102	67	2	.....
	Lactose	1,176	22	13	.....
III b C	Ordinary	1,782	18	7	
	Whey	1,188	.....	1	.....
	Lactose	2,574	5	.....	.....
III b E	Ordinary	112	4	16	
	Whey	.....	.....	1	.....
	Lactose	1	.....	.....	.....

SEVEN DAY COUNTS ON PURE CULTURES FROM BUTTER.—*Continued.*

Germ.	Media.	Dilutions. 10,000.	100,000.	1,000,000.	10,000,000.
D-L (lactic)	Ordinary	10,150	1,122	150	14
	Whey	12,530	1,650	224	33
	Lactose	7,164	990	176	21
A-S (lactic)	Ordinary	4,179	660	65	3
	Whey	4,179	528	45	5
	Lactose	4,760	462	48	1
VIII b A (yellow)	Ordinary	153	7	3	.....
	Whey	25	2	1	.....
	Lactose	100	6	1	.....
D-L (lactic)	Ordinary	13,250	1,000	198	20
	Whey	14,850	800	100	19
	Lactose	17,100	1,700	207	17
A-S (lactic)	Ordinary	3,600	contaminated	37	contaminated
	Whey	3,600	450	31	1
	Lactose	3,150	375	43	9
VI c A (lactic)	Ordinary	17,550	3,600	450	26
	Whey	22,950	2,250	300	29
	Lactose	21,600	2,250	400	40
IV c B (lactic)	Ordinary	20	.....	.....	.....
	Whey	15	.....	.....	.....
	Lactose	23	.....	.....	.....
D-L (lactic)	Ordinary	10,800	1,540	127	19
	Whey	11,250	1,750	158	13
	Lactose	11,250	1,100	163	20
A-S (lactic)	Ordinary	3,600	800	62	7
	Whey	2,250	500	75	2
	Lactose	4,950	800	63	5
VI c A (lactic)	Ordinary	11,700	700	208	18
	Whey	14,850	300	218	14
	Lactose	13,500	350	180	19
IV c B (lactic)	Ordinary	6,300	1,650	58	7
	Whey	6,300	200	61	3
	Lactose	5,850	300	82	12
D-L (lactic)	Ordinary	16,119	3,564	250	18
	Whey	20,298	2,574	180	10
	Lactose	24,283	2,244	257	20
A-S (lactic)	Ordinary	4,536	contaminated	30	1
	Whey	3,240	256	29	3
	Lactose	3,240	288	29	1
IV c B (lactic)	Ordinary	7,164	contaminated	17	2
	Whey	5,970	62	9	5
	Lactose	11,343	100	19	6
VI c A (lactic)	Ordinary	29,850	(cont.) 3,582	462	45
	Whey	37,611	2,388	382	30
	Lactose	26,268	2,388	326	35

RESULTS.

Lactic Germs.				Associative Germs. (not lactic.)			
D-L.	A-S.	VI c A.	IVc B.	III b G.	IV b D.	III b C.	VIII b E.
* W	O	O	L	L	L	O	O
L	W	W	O+L	O+W	L	O+L	O
O	O+W	O	L	O	O	O	O
W	O						
L	W+L						
L	O						

*O = ordinary agar; W, whey agar; L, 4% lactose agar.

COMPARISON OF GROWTH OF DAIRY GERMS, ETC.

The lactic germs grow equally well on ordinary and on lactose agar while the associative germs prefer the ordinary agar. However the results are not especially marked in either case.

REPORT OF THE HORTICULTURIST.

To the Director:

Sir:—I herewith submit the following report of my work as horticulturist for the past year. It may be summarized as follows:

1. The South Haven Sub-station.
2. Cooperative Experiments.
3. Consultations upon Horticultural Matters.
4. Correspondence.

SOUTH HAVEN SUB-STATION.

During the year the charge of the station has remained in the hands of Frank A. Wilken and a general report of the work performed during the growing season of 1907, was given in a bulletin submitted early in the spring.

For the most part, everything is in excellent condition although, as stated last year, the freeze of October, 1906, killed back the most of the grapes and bush fruits and destroyed the young peach trees and some of the Japanese plums. However, the apples, plums, pears and cherries escaped with little, if any, injury and are looking well. The plantation was made largely with the idea of testing the value of the different varieties and as only two trees of a kind were used, it has not been possible to carry on any very definite experimental work along other lines. Two years ago, however, plantings of apples, peaches and European and Japanese plums were made for the purpose of testing and comparing merits of tillage and mulching for these fruits, using various modifications. All of the trees are making a good growth but it is as yet too early to reach any definite conclusions.

Spraying. In addition to the general spraying of the trees which is

carried on along lines shown by previous experiments to give the best results, a series of experiments have been taken up to test the value of sulfur-lime mixtures as fungicides. The test included not only a trial of some of the commercial brands now upon the market, using them at the rate of one part to fifty parts water, but we are comparing them with a home-made mixture containing three pounds sulfur and five pounds lime in fifty gallons. These are being used upon all kinds of fruits not only to test their value as fungicides, but to see what effect, if any, they will have upon the control of plant lice, scale insects, curculio, codling moth, etc. While this remedy is not pleasant to apply when used at the above strength, it is comparatively inexpensive, particularly if it serves the double purpose of fungicide and insecticide, and its use should be adopted as a substitute for Bordeaux mixture and arsenicals.

COOPERATIVE EXPERIMENTS.

An increased amount of attention has been given to cooperative experiments with various fruit and vegetable crops in different parts of the state. These may be classified as spraying, fertilizer and cultural methods.

Spraying. As a result of experiments carried on for a number of years, we have demonstrated conclusively that apple scab and codling moth can be readily controlled by spraying. For many years it has been claimed that no benefit can be derived from the spraying of apple trees unless the work is done within ten days after the petals have fallen as the calyx will be closed, thus making it impossible to place any of the poison inside the calyx, hence later sprays could not prevent the entrance of the codling moth larva. So far as the codling moth itself is concerned, we are never greatly impressed with the benefit of this first application as the larvae does not appear until from three to five weeks after the petals have fallen and in the case of most varieties, it is difficult to deposit any of the poison in the calyx during the first week after the petals have fallen as the filaments of the stamens fill the tube. We would, however, emphasize the importance of spraying at this time, with Bordeaux mixture and an arsenical in order to coat the fruit and leaves, to prevent both the attack of fungi and apple scab and to destroy such leaf-eating insects as may be upon the trees.

So far as the codling moth is concerned, however, the application made two or three weeks later has been found even more effectual. The eggs of the first brood are almost entirely deposited upon the leaves and as the small fruits are always several inches away, the larvae must feed upon the leaves before reaching the fruit. It will also generally be well to spray the trees two weeks later for the apple scab, as well as for any belated larvae of the codling moth. The value of one or two applications in August for the control of the second brood has also been brought out during the year, as where the trees were thoroughly sprayed during the first half of August very little injury was done, while trees that did not receive attention at that time, although thoroughly sprayed during May and June, suffered seriously from this insect. While one application in August has generally given good results, in some cases where serious injury has been done by the codling

moth in previous years, a second application has been found quite profitable. Whether Bordeaux mixture should be used in either of the August applications depends largely upon the season and upon the varieties. If the orchard consists largely of kinds that are injured by apple scab, it will certainly be well to use Bordeaux for at least one application in August, and all varieties will be sufficiently benefitted to make it worth while in seasons when the weather is cold and wet.

The above conditions also materially affect the number of applications that should be given during a season. It has been demonstrated that the trees should be sprayed just before the blossoms open and not less than three applications should be made later in the season. In addition to this, many of our best growers are convinced of the importance of making one, if not two, of the later applications mentioned above. For cherries and plums our experiments show that three applications can be made to advantage, one just before blossoming, and two others after the fruit has set, at intervals of two weeks. In the case of the early varieties of plums that are subject to the brown rot, the use of one or two sprayings of sulfur-lime solution (3 lbs. sulfur and 5 lbs. lime in 50 gals.) at intervals of ten days, beginning just before the fruit colors, or earlier if the season is favorable to the rot, will do much to hold it in check. In the case of peach trees it will be well, especially in case of varieties subject to the attack of leaf curl, to spray them with copper sulfate solution (2 lbs. in 50 gals. water) three or four weeks before the blossom buds open. If the work is thoroughly done, this will entirely prevent the injury that often results from the attack of this disease.

When curculio have been troublesome, or the fruit injured by scab and other fungous diseases, it will generally be well to spray a week or ten days after the petals have fallen, but care should be taken to use very weak Bordeaux mixture as otherwise the foliage will be injured. As a rule, not more than two pounds of copper sulfate and three or four pounds of lime should be used in fifty gallons, adding two pounds of arsenate of lead to control the curculio.

In the case of varieties subject to the attack of brown rot and scab, the application of weak sulfur-lime solution can be made as suggested for the same trouble upon the plum.

For the control of insect diseases of the pear, the treatment required has been practically the same as for the apple except that there has been, as a rule, less need of the August applications and then, of course, only upon the winter varieties. Some varieties of pears, such as Flemish Beauty, have been almost ruined by apple scab where the trees have been allowed to go unsprayed. In such cases, very careful attention to the spraying must be given and one application must be made as late as possible previous to the blossoming and two others should follow the dropping of the petals at intervals of ten days.

Particular attention has been paid to experimental work with grapes, as for a number of years serious losses from black rot have been experienced in the vicinity of Lawton. It has been demonstrated that this disease can be very largely controlled by spraying with Bordeaux mixture. Last year in a number of instances the grapes from sprayed vineyards were sold at $150 to $200 per acre while the crop from unsprayed vineyards growing under similar conditions was entirely de-

troyed by the black rot. The same formula as for apple orchards (4 bs. copper sulfate and 6 lbs. lime in 50 gals. water) has been used n most cases and has given excellent results.

For vineyards of bearing age, from fifty to sixty gallons per acre re commonly used but, especially after the fruit has set, it is desirable o use from sixty to eighty or even one hundred gallons per acre, using power outfit which will carry a high pressure, and driving slowly.

For the spraying of vineyards there are several outfits now upon the narket that are giving good results. While the Vermorel nozzle answers airly well for this purpose, more or less difficulty is experienced owing o the clogging of the nozzle because of the small orifice, and to lessen he trouble from this source it has been found well to use one "Friend" r "Mystry Jr." nozzle for the center of the trellis with a Vermorel ozzle above and below.

The spraying can be greatly aided by taking pains to clean up the ineyard. All of the mummied and rotted fruit should be removed from he vines when they are pruned and the prunings should be burned. t also assists in controlling the disease if the vineyards are plowed as leeply as possible, taking pains to bury the leaves and rotted grapes, f possible before the growth has started. As the tendrills which remain upon the wires are also a source of contagion, it will aid materially f these are burned or cut off from the wires.

As soon as the pruning and tying of the vines has been completed, he vineyard should be sprayed, using copper sulfate solution (2 lbs. n 50 gals. water) taking pains not only to thoroughly soak the vines, ut the ground beneath.

As a rule, it will not be necessary to use Bordeaux mixture until ust before the blossoms are ready to open, at which time a thorough pplication should be given, but if the rot has been very troublesome n previous years and if the weather is favorable for its development. spraying can often be given to advantage when a growth of twelve r fifteen inches has been made. As soon as the fruit has set and has eached the size of small peas, another spraying should be given and his should be kept up at intervals of ten days to two weeks until July 0. If the rot is still troubling and conditions favor its spread, one r two later applications, using either soda Bordeaux or a weak soluion of copper sulfate (1 lb. to 150 gals. water) can be given.

As a rule, five applications of Bordeaux mixture will be sufficient o hold the black rot in check and also prevent the attack of mildews nd other fungous diseases and as this can be made at a cost of about 1.00 per acre for each application, including the labor and material, t will be found a very profitable operation in sections where the rot as prevailed. That this has been found the case at Lawton can be hown from the fact that while only two or three persons sprayed their ineyards in 1906, the number increased to ten or fifteen in 1907 and in 908 it is reported that at least 125 power spraying outfits have been sold in that section alone and that 75 to 90 per cent of the vineyards re being sprayed.

It is probable, however, that many will not secure satisfactory results, s it generally takes two or three years for a person to learn how to spray so as to get the best results, the difficulties being in part a lack of care in making the mixture, or, more often, a lack of thoroughness

in making the applications, or failure to make the application at th
proper time.

It is now recognized that spraying is in no way a cure for the dis
eases and as it must be used as a preventative only, the importance i
recognized by all of beginning spraying before the disease has ap
peared and then making sure that not only the fruit but the foliag
is at all times covered with the spray mixture.

For several years serious losses have been experienced from rose bug
by grape growers in the lake shore districts where the soil is of a sand
nature. Attempts have been made to control them by the use of Pari
green and other poisons but from the fact that the principal injur
is done to the blossoms, it has been found impossible to destroy then
in this way, especially as they seem to avoid the parts covered wit
the poison. Hand picking has been resorted to in many cases but it i
very expensive and when the insects appear in vast numbers, as is ofte
the case, serious injury is often done to the crop before they can b
destroyed in this way. The use of arsenate of lead has given bette
results as it is possible to use a greatly increased amount of arseni
and in this way the insects are poisoned before very much harm ha
been done, but even with five pounds of arsenate of lead in fifty gallon
of water, it sometimes happens that the insects are so numerous tha
a large portion of the crop is destroyed.

During the year we have been experimenting with arsenate of lea
used at the rate of five pounds in fifty gallons together with one quar
of molasses. The insects prefer this to the blossoms and as they si
up the sweetened water they take in the poison and are destroye
with less injury to the plants than when poison has been sprayed upo
the portions they are eating.

A much cheaper remedy and one that is nearly as effectual is mad
by substituting arsenite of lime for the arsenate of lead. This is pre
pared by dissolving the arsenic by boiling one pound of arsenic an
one pound of sal soda in one gallon of water until the arsenic has bee
dissolved. This is then diluted to five quarts and one quart of th
solution, one pound of slaked lime and one quart of black-stra
molasses used with fifty gallons of water.

We have also been carrying on quite extensive experiments to discove
the value of arsenate of lead as a substitute for Paris green and othe
arsenicals and have been well pleased with the results. The bette
brands contain about sixteen per cent of arsenious oxide or about one
third as much as is found in Paris green. Hence if one pound o
arsenate of lead is used for fifty gallons of water or Bordeaux mixtur
it will furnish the same amount of arsenic as will be provided by fiv
ounces of Paris green, which is about the usual amount used. Arse
nate of lead, however, has the advantage of being practically insolubl
and hence it is possible to use a much larger amount if needed an
we have found that it is generally well to use one and a half to tw
pounds for fifty gallons for most insects. There are cases, however
when four or five pounds may be desirable. Arsenate of lead also ha
the merit of being very adhesive and when thoroughly applied to a
tree the occasion for repeating the application will be much less tha
when Paris green, which readily washes off, is used. In fact, considerin
the arsenical alone, it is possible to lessen the number of application

required for a crop fully one-third by using arsenate of lead in place of Paris green, but as it is necessary to keep the growing portions of the plants covered with a fungicide to prevent the attack of various diseases, this will make but little difference in actual practice except that the efficiency of the fungicide will be greatly increased.

Fertilizers. During the year we have been carrying on a large number of experiments with fertilizers upon apple and peach orchards, vineyards and strawberry plantations. For the most part we have relied upon various combinations of nitrate of soda, acid phosphate, dissolved bone and sulfate of potash. These have been applied to the crops in such a way as to determine the needs of the soils and of the particular crop. Some of the plots received a mixture containing combinations of three elements while others were given combinations of two of the materials, and still others received the elements singly.

While the results have varied somewhat with the different crops and upon soils of different kinds and conditions, a mixture containing 100 to 150 pounds nitrate of soda, 200 to 300 pounds sulfate of potash and 500 to 600 pounds of acid phosphate has given good results when used at the rate of from 300 to 500 pounds per acre. For some crops, such as potatoes, a considerable larger amount has been found profitable when the soil contains a fair amount of humus. Often with the use of a liberal amount of stable manure the addition of sulfate of potash and acid phosphate has so increased the crop as to give a very profitable return for the fertilizer used.

Cultural Methods. The experiments undertaken at the South Haven Sub-station to show the comparative value of tillage and mulching for orchards have been duplicated in a number of places. The experiments are generally arranged in four groups, one plot being given clean culture, a second clean culture with a cover crop sown about the first of August, a third plot heavily mulched with straw and a fourth plot has a similar amount of stable manure added to the straw mulch. The annual growth of the trees in each plot has been recorded and a record is kept of the crop produced.

CONSULTATIONS UPON HORTICULTURAL MATTERS.

Letters are received regularly regarding the best methods of handling orchards and fruit plantations and various horticultural crops which it is not possible to answer in a definite manner without knowing something of the local conditions. As my work as State Inspector of Orchards and Nurseries and in overseeing cooperative work frequently takes me to different parts of the state, I have made it a practice to arrange to inspect such premises when conditions seem to make it desirable and have thus been able to offer more definite advice. In many instances I have been able to locate troubles that were not suspected by the owners which, of course, would not have been possible had reliance been placed only upon letters received.

CORRESPONDENCE.

During the year several thousand letters of inquiry, many of which enclosed specimens for examination while others related to the adaptation of various parts of Michigan for fruit culture, or asked for advice

as to methods of handling fruit and other crops have been received, an to give this correspondence proper attention has taken a large amoun of time.

In carrying on cooperative work it has not been possible to secur as definite results as might be wished because, as a rule, the partie upon whose premises the experiments are conducted, although intereste in the results, are generally too busy at the time the crops are har vested to give the desired attention to weighing and noting result secured from the different plots. In order to carry on the work to th best advantage, several assistants who could keep a careful oversigh of the experiments and then, as they would not only have these result available for the purpose, but would be well informed upon the method that are being used to secure the best results, they could be used t advantage in sections of the state where they were in charge of th experimental work as lecturers at farmers' institutes and other gather ings. I trust that some such provision can be made for the coming yea

Respectfully submitted,

L. R. TAFT,

Horticulturist.

East Lansing, June 30, 1908.

REPORT OF THE CHEMIST.

Director R. S. Shaw, East Lansing, Mich.:

Dear Sir:—I submit herewith a brief report of the work of th chemical division for the year ending June 30th, 1908.

CHANGES IN THE STAFF.

On October 1st, 1907, Miss Dorothea Moxness, who had been a efficient assistant in this division for a year and a half, resigned t accept a more profitable position in industrial work. In filling th vacancy it was desired to get a man of broad general training and on with some experience in research work. In conformity with thes views the position of Research Assistant was created and Dr. S. L Jodidi appointed to fill it.

Dr. Jodidi began his duties at the station February 1st, 1908, and can unqualifiedly speak in the highest terms of praise for his effici ency and devotion to the work.

ADAMS FUND.

The work undertaken under the Adams fund has been confined t a study of the agricultural value or availability of the nitrogen i peat.

About one-seventh of the State of Michigan consists of swamp or pea lands, the greater part of which is not used to any extent for agricul tural purposes.

When it is considered that the dried peat contains from 2 to 4% of nitrogen and in some cases as much as 5 or 6%, it will be realized that a valuable source of nitrogen is right here at our hand. But the question is, how can it be made available?

In order to better understand the problem in hand it was thought best to first determine in what forms the nitrogen is present in the peat and with this narrower problem Dr. Jodidi has been busy. No definite conclusions have been reached as yet.

Other lines of work looking to the utilization of the peat will be undertaken as soon as opportunity permits.

During the past winter an experiment was undertaken in the greenhouse to determine the availability of the nitrogen of dried peat for growing crops. Three crops possessing different feeding powers were selected for the test, namely: oats, peas and carrots. The chemical work has not been completed, consequently, it is not possible to give any data of the experiment at this time.

It was found necessary to discontinue our work on the availability of the phosphorus compounds in the soil during the past year but it is hoped to take this work up again in the fall.

HATCH FUND.

During the past winter we were called upon by the agronomy division to determine the protein in more than 400 samples of corn that were used in the work on corn breeding and selection. This led to a consideration of the variation of the protein in the individual kernels of the same ear. It has always been supposed that the protein content of the kernels of a single ear was uniform or at most, varied only slightly. The results of our investigations showed variations as great as five per cent between kernels on the same ear and in close proximity to each other and that variations as great as two and three per cent are very common. It is desired to continue this work still further during the coming winter. Mr. C. B. Collingwood has performed the work in connection with this investigation.

The fertilizer experiment begun last year in conjunction with Mr. Sackett of the bacteriological division on the Howarden farm at Edwardsburg, Mich., is being continued during the present season. Mr. A. R. Potts has rendered very valuable service in looking after the practical end of the experiment. The soil is responding to fertilization and liming and very interesting results were obtained this year on the clover plots. The original plan of continuing the experiment five years before making a report will be carried out.

FERTILIZER INSPECTION.

The results of the fertilizer inspection for 1907 revealed the fact that a few companies were apparently not making any effort to have their goods conform with their published guarantees. No prosecutions were made however but the publication of the results in the bulletin served to call the attention of the consuming public to the shortages and in many instances settlements were made upon the results of the station's findings.

In closing this report I wish to bespeak my thanks for all who have assisted in the work of the division during the past year.

Respectfully submitted,
ANDREW J. PATTEN,
Chemist.

East Lansing, June 30, 1908.

REPORT OF THE ENTOMOLOGIST.

Director R. S. Shaw:

Following is a brief report of the work of the Division of Entomology during the year ending June 30, 1908.

One bulletin was issued during the year, viz.: No. 251, dealing with insects, either new or of special interest, which have recently appeared.

The correspondence has grown to such a bulk as to require a very considerable proportion of the time of the writer, especially during the summer months. There is a steady stream of queries sent in by farmers, fruit men, millers, market gardeners, housewives, foresters, owners or keepers of ornamental plantings and green-houses, etc., which queries the writer is always glad to answer so far as his ability permits, since they serve to strengthen the bond between the station and the people of the state.

Several pests have made their presence felt rather more than ordinarily. First, the oats thrips which took advantage of the late, cold spring and subsequent dry, hot spell, to multiply in an astonishing manner, to the serious detriment of the young oats.

Rose-chafers were abundant and managed to do much injury. An attempt to control by spraying with lead arsenate was made near Decatur. The success of the experiment is related in bulletin 251.

A new gooseberry pest with habits similar to those of the gooseberry fruit-worm has appeared and done severe injury to the gooseberry crop. We managed to rear the adult and hope to get the life history this year.

Short trips have been made to various meetings of societies of a scientific or applied nature, such as the Michigan Academy of Science, the State Forestry Convention and County Horticultural Clubs.

A trip was made to the region west of Saginaw to investigate bean troubles and one to Big Rapids to look into cucumber difficulties. Also a short trip to Paw Paw to look into the case of a beetle (Anomala) which was feeding on young apple trees.

These trips often result in bringing to the attention of the station, something foreign to the original objective but sometimes vastly more important.

The division has entered into cooperation with the Bureau of Entomology of our National Department of Agriculture in an experiment to determine practical methods of combating the tamarack saw-fly, which is at present doing enormous injury in the north. In pursuance of this work the writer made a two weeks' trip to the northern part

of the state in company with Dr. A. D. Hopkins, chief of the division of forest insects of the bureau of entomology. On the trip many points in the life history, previously in doubt, were settled besides bringing to light much loss of timber from other insect attacks.

Two projects borne by the Adams fund of the station are now under way, viz.: A study of insect diseases, or more exactly, a study of fungi which causes diseases among insects, preferably epidemic diseases. The immediate reason for this was an attempt to control forest pests by such diseases since sprays are not practical under forest conditions. A number of such fungi obtained from the dead bodies of insect victims have been studied and their life-history followed from germination to fructification and two, found on tamarack saw-flies, one in America and one in England, have been grown in quantity in order to make an attempt to scatter the disease widely this summer through the infested region.

Another project soon to be under way is a careful study of the manner in which insecticides kill insects. This will require very careful investigation extending over a period of years and to carry on this work, Dr. G. E. Shaffer of Cornell University has been engaged.

The Insectary, a greenhouse which was so kindly added to our equipment last fall, has proven perfectly satisfactory in every respect. A number of species of insects have already been bred and during the present season the number will be limited only by the time at our disposal.

Mr. Z. P. Metcalf has been a very able assistant during the past year. He came in September and left about the middle of June, having secured a much better paid position in another state. Mr. Yothers, of Idaho Agricultural College, has been engaged to fill the place.

Respectfully submitted,

R. H. PETTIT,
Entomologist.

East Lansing, June 30, 1908.

REPORT OF THE VETERINARIAN.

Professor R. S. Shaw, Campus, M. A. C.:

Dear Sir:—I have the honor to report as follows: As consulting veterinarian of the Experiment Station, I have made one trip to Westwood during the period in which Mr. Potts was in charge of the feeding experiments at that place. I have conducted fifteen postmortems upon animals submitted to the Experiment Station or to me as veterinarian, for analysis, and have examined twenty-two samples of tissue, forage, stock foods, etc., likewise submitted for information.

The correspondence of my portion of the station work has been fairly heavy, at times extremely so, and I hope that it may be more satisfactorily handled and recorded by stenographic assistance during the ensuing year.

I am unable to report the presence of any grave outbreaks of disease

within the state, but from the correspondence and specimens received, there seems to be a great deal of trouble among sheep from verminous diseases. These disorders are in the main of common occurrence among sheep, and are readily recognized by veterinarians. Their existence in harmful degree in certain localities seems to depend upon the lack of information of sheep owners regarding methods of prevention and upon especially favoring conditions upon their premises for the development of such outbreaks.

While the knowledge of sheep diseases is still much abridged and much may be learned through experimental efforts, I feel that the station is not at present provided with facilities for the work, and would not ask its adoption, I believe however that much good would be derived by stock owners from a bulletin describing the common diseases of sheep, and the methods by which they are successfully dealt with at present.

Respectfully submitted,
L. M. HURT.

East Lansing, June 30, 1908.

REPORT OF MICHIGAN WEATHER SERVICE FOR THE BIENNIAL PERIOD ENDING JUNE 30, 1908.

The work of the Michigan Weather Service during the past biennial period has been carried forward on lines very similar to those of preceding years. The principal work, outlined by law, is the collection and compilation of meteorological statistics and the dissemination of forecasts, frosts and coldwave warnings. The service has in operation a total number of 113 cooperative, or voluntary stations, at which daily readings of the thermometers and rain gage are made and a record kept of the prevailing wind direction, general cloudiness and other meteorological phenomena.

The state is fairly well covered with stations so that almost any locality can secure records, which, if not taken exactly at that place, are from some place nearby, are fairly representative. The value of these records is becoming more apparent every day. It is a matter of much interest and great importance to note the variety of uses to which they are put. Perhaps one of the most important businesses now calling for much meteorological data is the water power, which is being developed throughout the state. It is only in recent years that the commerical world has come to recognize and utilize the enormous possibilities latent in the fast, fairly even-flowing and numerous rivers of the state. This is particularly true in the Lower Peninsula. Very few states in the Union are so favorably situated as regards water-power possibilities.

One of the most important items of consideration in the development of any water-power plant is a long rainfall record, and this office has answered almost innumerable requests for rainfall data in all parts of the state which will have a bearing on the water-power projects

both in operation and contemplated. In no other way could the weather bureau have aided these projects so effectually as by the long series of observations that it has prepared at very little expense during the past twenty years.

Cities and villages are constantly calling for rainfall data in connection with their public works, especially sewer systems. The medical profession is using all of our records, especially temperature, precipitation and cloudiness. The manufacturers, spurred on by a keener competition, are considering the effect of the different phases of climate on their product, and, altogether, the Weather Service is finding itself a very important source of information.

The observers' work is done by a corps of cooperating observers who perform their services voluntarily and without any remuneration other than the publications that this office can send them. The work of the voluntary observers, as a whole, is very satisfactory, prompt and intelligent. The administrative work of caring for this large corps of observers is considerable. One phase of it is a constant course of instruction, because the personnel of the observers is changing, more or less, constantly. The various stations must be kept fully equipped with serviceable instruments and the stationery used in connection with observation work. On the other hand, an immense amount of labor is necessary in collecting, carefully checking and compiling their reports so that they can be easily referred to.

In the distribution of the daily forecasts and the occasional frost and coldwave warnings a great advance has been made in the past two years, due principally to the rapid extension of the telephone to the rural districts. By a system of cooperation with the principal telephone companies throughout the state our forecasts are regularly delivered to over twelve hundred exchanges, from which radiate thousands of farmers' telephone lines. By this system any farmer who has access to a telephone can secure the forecast every morning about ten a. m. by simply calling up central and asking for it. This is not only true for the farmer, but for any telephone subscriber. Through this telephone cooperation the weather bureau forecasts are at the disposal of over 140,000 subscribers in Michigan.

The rural mail delivery has not proved a satisfactory means of dissemination, principally because most of the rural mail carriers leave on their trips between 7 and 8 a. m., while the weather bureau forecast for "tonight and tomorrow" is not available for issue until about 9 a. m. While the telephone, at present, does not reach as many as the rural mail delivery, it is a more satisfactory method of distribution on account of its involving much less labor and expense. The rapid extension of the rural telephone lines indicates that it will not be many years before nearly every progressive farmer has a telephone or access thereto.

The weekly, monthly and annual publications of the service have been continued along lines similar to those of previous years. The reports appear to be very popular and are much sought after.

C. F. SCHNEIDER,
Director.

METEOROLOGICAL TABLES.

METEOROLOGICAL OBSERVATIONS.

Summary of the meteorological observations for 1907, at Agricultural College, East Lansing, Mich.

Months.	Mean daily temperature in open air.	Mean daily barometer reduced to freezing point	Mean daily maximum temperature.	Mean daily minimum temperature.	Total rain or melted snow, inches.	Total snowfall, inches.
January	22.5	29.10	29.1	16.6	3.97	11.25
February	18.6	29.02	28.3	9.9	0.25	2.70
March	36.4	28.96	47.3	29.9	2.84	2.90
April	36.4	28.88	46.2	29.3	2.81	0.20
May	50.8	28.94	61.4	41.0	2.22	0.25
June	65.3	28.95	75.3	54.7	2.37	.00
July	69.8	28.91	79.2	60.7	4.30	.00
August	66.5	29.07	76.5	54.5	2.87	.00
September	59.1	28.97	69.6	54.2	4.68	.00
October	50.5	29.02	55.5	36.5	2.22	0.03
November	34.8	28.99	43.0	28.9	1.83	0.30
December	27.2	28.85	33.8	21.7	4.19	25.50
Year	44.8	28.97	53.8	36.5	34.55	43.13

Meteorological observations for the month of January, 1907, at Agricultural College, East Lansing, Mich.

Day of month.	Thermometer in open air.		Barometer reduced to freezing point.		Registering thermometers.		Character of day.	Prevailing wind direction.	Precipitation.		Day of month.
	7 a. m.	7 p. m.	7 a. m.	7 p. m.	Maximum.	Minimum.			Inches, rain and melted snow.	Snowfall, inches.	
1	30	31	29.08	29.23	34	29	Cloudy	W	0.0	0.0	1
2	31	35	29.31	29.26	32	28	Cloudy	e	0.35	3.0	2
3	38	38	29.06	28.96	40	35	Cloudy	s w	0.0	0.0	3
4	24	29	29.07	29.01	39	23	Clear	w	0.0	0.0	4
5	30	37	29.12	29.02	43	29	Clear	s	0.0	0.0	5
6	41	45	29.09	29.12	48	36	Clear	s	0.06	0.0	6
7	46	37	29.19	29.08	45	35	Cloudy	s	0.77	0.0	7
8	35	33	29.05	29.08	43	33	Cloudy	n w	0.57	0.0	8
9	15	15	29.21	29.16	33	12	Pt. cloudy	n w	0.0	trace	9
10	17	30	28.73	28.81	30	10	Cloudy	w	0.0	trace	10
11	24	29	28.82	28.84	33	22	Cloudy	s	0.0	0.0	11
12	27	31	28.65	29.02	34	25	Cloudy	e	0.25	2.50	12
13	30	33	29.14	29.03	33	20	Cloudy	s e	trace	0.0	13
14	34	28	28.98	29.09	35	28	Cloudy	w	0.02	0.25	14
15	21	19	29.21	29.27	28	19	Cloudy	n	0.0	0.0	15
16	18	22	29.24	29.20	23	15	Cloudy	e	0.0	0.0	16
17	19	28	29.03	29.04	29	16	Cloudy	e	0.05	0.50	17
18	28	34	28.99	28.96	34	23	Cloudy	s	0.0	0.0	18
19	48	49	28.47	28.35	51	38	Cloudy	s	1.17	0.0	19
20	18	9	28.62	29.09	31	9	Pt. cloudy	w	0.03	0.35	20
21	8	14	29.33	29.22	14	5	Pt. cloudy	w	0.04	0.45	21
22	6	5	29.23	29.46	13	4	Clear	w	0.50	5.50	22
23	—6	7	29.44	29.42	12	—11	Cloudy	s	0.0	0.0	23
24	8	15	29.34	28.94	15	6	Cloudy	s e	0.05	0.50	24
25	18	6	28.87	28.94	20	5	Cloudy	w	0.0	trace	25
26	—5	9	29.13	29.18	15	—6	Clear	s	0.0	0.0	26
27	10	10	29.23	29.29	19	6	Pt. cloudy	s w	0.02	0.25	27
28	10	12	29.35	29.31	15	4	Cloudy	s w	0.0	0.0	28
29	13	17	29.25	29.23	20	10	Cloudy	e	0.04	0.40	29
30	6	8	29.33	29.36	16	4	Pt. cloudy	e	0.02	0.25	30
31	15	24	29.19	29.06	24	4	Pt. cloudy	s e	0.03	0.30	31
Sum	657	739	901.75	902.03	901	516			3.97	11.25	
Average	21.2	23.8	29.09	29.10	29.1	16.6					

Meteorological observations for the month of February, 1907, at Agricultural College, East Lansing, Mich.

Day of month.	Thermometer in open air.		Barometer reduced to freezing point.		Registering thermometers.		Character of day.	Prevailing wind direction.	Precipitation.		Day of month.
	7 a. m.	7 p. m.	7 a. m.	7 p. m.	Maximum.	Minimum.			Inches, rain and melted snow.	Snowfall, inches.	
1	15	33	28.97	28.78	33	8	Cloudy.	e	trace	0.0	1
2	34	7	28.56	28.81	34	7	Cloudy	w	0.0	0.0	2
3	4	5	29.25	29.29	10	2	Cloudy	n	0.02	0.25	3
4	2	7	29.27	29.14	10	—2	Pt. cloudy	n	0.0	0.0	4
5	9	8	29.07	29.15	14	6	Pt. cloudy	n	0.03	0.30	5
6	—5	11	29.29	29.34	18	—6	Clear	w	0.0	0.0	6
7	12	14	29.35	29.21	23	9	Pt. cloudy	s	0.0	0.0	7
8	18	25	29.16	28.99	25	5	Cloudy	s	0.0	trace	8
9	26	32	28.86	28.84	32	9	Cloudy	s	0.0	0.0	9
10	29	23	28.61	28.82	33	23	Pt. cloudy	n w	0.02	0.20	10
11	9	6	28.94	29.19	23	6	Clear	n w	0.0	0.0	11
12	3	22	29.15	29.12	22	—5	Cloudy	s	0.0	0.0	12
13	24	44	28.89	28.48	46	20	Clear	s	0.0	0.0	13
14	20	19	28.74	29.09	44	17	Pt. cloudy	n w	0.02	0.20	14
15	19	36	28.94	28.74	40	14	Clear	s w	0.0	0.0	15
16	31	35	28.78	28.88	36	29	Cloudy	s	0.0	0.0	16
17	28	30	29.01	29.04	37	24	Pt. cloudy	w	0.0	0.0	17
18	27	42	28.86	28.48	46	25	Pt. cloudy	s	0.02	0.25	18
19	27	32	28.51	28.66	42	26	Clear	w	0.0	0.0	19
20	26	16	28.63	28.72	32	16	Pt. cloudy	n e	0.12	1.25	20
21	5	5	28.90	29.06	17	—3	Pt. cloudy	w	0.0	0.0	21
22	—7	11	29.36	29.53	14	—10	Clear	w	0.0	0.0	22
23	6	15	29.61	29.34	21	—3	Clear	e	0.0	0.0	23
24	21	24	28.98	29.16	32	13	Pt. cloudy	w	0.02	0.25	24
25	16	18	29.25	29.25	23	15	Clear	e	0.0	0.0	25
26	14	24	29.11	28.93	30	11	Clear	s	0.0	0.0	26
27	22	18	29.25	29.25	24	10	Cloudy	e	0.0	trace	27
28	16	28	29.15	29.16	32	13	Cloudy	e	0.0	0.0	28
Sum	451	590	812.45	812.45	793	279			0.25	2.70	
Average	16.1	21.1	29.02	29.02	28.3	9.9					

Meteorological observations for the month of March, 1907, at Agricultural College, East Lansing, Mich.

Day of month.	Thermometer in open air.		Barometer reduced to freezing point.		Registering thermometers.		Character of day.	Prevailing wind direction.	Precipitation.		Day of month.
	7 a. m.	7 p. m.	7 a. m.	7 p. m.	Maximum.	Minimum.			Inches, rain and melted snow.	Snowfall, inches.	
1	23	38	29.04	28.58	38	20	Cloudy	s e	0.24	0.0	1
2	28	38	28.64	28.69	39	25	Cloudy	w	0.02	0.15	2
3	14	19	28.87	29.01	28	13	Pt. cloudy	n w	0.02	0.20	3
4	15	32	29.13	29.04	32	12	Cloudy	s w	0.0	0.0	4
5	25	26	28.91	29.05	34	18	Clear	w	0.0	trace.	5
6	14	26	29.34	29.23	30	12	Clear	n e	0.0	0.0	6
7	23	29	29.01	28.77	29	22	Cloudy	s e	0.25	2.50	7
8	28	29	28.97	29.16	34	25	Pt. cloudy	e	0.0	0.0	8
9	17	30	29.28	29.18	32	12	Clear	e	0.0	0.0	9
10	27	33	29.10	29.20	38	10	Clear	n	0.0	0.0	10
11	28	37	29.23	29.02	42	24	Clear	s	0.22	0.0	11
12	41	40	28.63	28.67	44	35	Cloudy	s	0.0	0.0	12
13	34	32	28.73	28.70	40	30	Cloudy	n e	0.0	trace	13
14	28	30	28.84	29.03	35	28	Pt cloudy	n w	0.01	0.10	14
15	32	34	29.12	29.24	40	30	Clear	s w	0.0	trace	15
16	40	57	29.14	28.94	57	35	Clear	s w	0.0	0.0	16
17	38	35	29.10	29.27	47	35	Pt. clear	n e	0.0	0.0	17
18	25	36	29.34	29.11	42	23	Cloudy	e	0.0	0.0	18
19	33	47	28.63	28.64	54	30	Pt. cloudy	s w	0.19	0.0	19
20	28	37	29.09	29.04	46	27	Pt. cloudy	n	0.0	0.0	20
21	35	51	28.85	28.63	57	29	Cloudy	s	0.0	0.0	21
22	47	64	28.64	28.66	75	40	Pt. cloudy	s w	0.0	0.0	22
23	47	59	28.88	28.60	65	45	Cloudy	s e	0.67	0.0	23
24	39	45	28.97	29.11	60	38	Pt. cloudy	n e	0.0	0.0	24
25	39	54	28.08	28.87	59	35	Clear	s	0.0	0.0	25
26	60	56	28.80	28.98	70	47	Pt. cloudy	s	0.15	0.0	26
27	61	65	28.69	28.57	69	55	Cloudy	s w	0.60	0.0	27
28	48	52	28.86	28.86	66	47	Cloudy	s e	0.15	0.0	28
29	57	49	28.66	28.66	67	49	Pt. cloudy	s w	0.32	0.0	29
30	38	47	29.21	29.18	50	45	Pt. cloudy	w	0.0	0.0	30
31	25	27	29.42	29.46	46	23	Clear	n	0.0	0.0	31
Sum	1037	1214	898.20	897.15	1465	928			2.84	2.90	
Average	32.5	39.2	28.97	28.95	47.3	29.9					

Meteorological observations for the month of April, 1907, at Agricultural College, Eas Lansing, Mich.

Day of month.	Thermometer in open air.		Barometer reduced to freezing point.		Registering thermometers.		Character of day.	Prevailing wind direction.	Precipitation.		Day of month.
	7 a. m.	7 p. m.	7 a. m.	7 p. m.	Maximum.	Minimum.			Inches, rain and melted snow.	Snowfall, inches.	
1	17	28	29.48	29.34	32	16	Clear	n e	0.0	0.0	
2	26	39	29.30	29.08	44	21	Clear	s	0.0	0.0	
3	39	56	29.07	28.92	64	35	Cloudy	s	0.0	0.0	
4	48	48	28.74	28.69	56	46	Cloudy	e	trace	0.0	
5	26	27	28.99	29.08	48	22	Pt. cloudy	n e	0.0	0.0	
6	27	28	29.07	28.61	46	21	Clear	e	0.0	0.0	
7	35	47	28.57	28.19	47	26	Cloudy	s	0.11	0.0	
8	33	35	28.29	28.39	46	31	Cloudy	s w	0.03	trace	
9	30	27	28.39	28.53	34	27	Cloudy	n w	0.06	trace	
10	25	34	28.63	28.75	37	25	Cloudy	n w	0.0	trace	1
11	27	37	28.84	28.72	40	26	Pt. cloudy	w	0.0	0.0	1
12	33	33	28.53	28.64	35	33	Cloudy	s	0.19	0.20	1
13	32	26	28.69	28.94	35	26	Cloudy	n	0.0	trace	1
14	26	32	29.03	29.05	37	23	Pt. cloudy	n	0.0	trace	1
15	29	34	29.06	28.74	40	21	Pt. cloudy	s	0.0	trace	1
16	34	33	28.65	28.78	35	30	Cloudy	w	0.04	trace	1
17	31	33	28.95	28.94	36	28	Cloudy	n w	0.0	0.0	1
18	30	36	29.04	28.95	39	26	Clear	n	0.0	0.0	1
19	33	41	28.93	29.00	47	32	Pt. cloudy	n w	0.0	0.0	1
20	30	35	29.15	29.17	45	27	Clear	n w	0.0	0.0	2
21	39	45	29.21	29.05	54	26	Clear	s w	0.0	0.0	2
22	45	53	28.95	28.78	53	35	Clear	s	0.0	0.0	2
23	47	47	28.67	28.73	58	41	Pt. cloudy	s w	0.0	0.0	2
24	34	47	29.00	28.72	54	28	Pt. cloudy	w	0.03	0.0	2
25	36	37	28.84	28.96	55	35	Cloudy	n	0.04	0.0	2
26	28	41	29.10	29.15	46	26	Clear	n	trace	0.0	2
27	37	50	29.25	29.11	50	26	Clear	s e	0.0	0.0	2
28	48	64	28.99	28.77	71	53	Pt. cloudy	s	0.0	0.0	2
29	58	37	28.80	28.90	64	37	Cloudy	s	1.22	0.0	2
30	33	35	28.65	29.05	39	31	Pt. cloudy	n e	1.09	0.0	3
Sum	1016	1165	866.86	865.73	1387	880			2.81	0.20	
Average	33.9	38.8	28.90	28.86	46.2	29.3					

Meteorological observations for the month of May, 1907, at Agricultural College, East Lansing, Mich.

Day of month.	Thermometer in open air.		Barometer reduced to freezing point.		Registering thermometers.		Character of day.	Prevailing wind direction.	Precipitation.		Day of month.
	7 a. m.	7 p. m.	7 a. m.	7 p. m.	Maximum.	Minimum.			Inches rain and melted snow.	Snowfall, inches.	
1	39	45	29.22	29.19	51	28	Clear	n	0.0	0.0	1
2	43	53	29.21	29.12	57	35	Clear	s w	0.0	0.0	2
3	46	38	29.07	29.00	54	38	Pt. cloudy	w	0.09	0.0	3
4	32	38	29.09	29.08	41	31	Pt. cloudy	n w	0.05	trace	4
5	42	45	29.16	28.96	51	33	Cloudy	e	0.03	0.0	5
6	45	54	28.98	28.91	59	43	Cloudy	w	0.05	0.0	6
7	48	55	28.91	28.93	61	45	Cloudy	s w	trace	0.0	7
8	52	57	28.95	28.85	63	47	Clear	s w	0.0	0.0	8
9	54	62	28.87	28.80	70	43	Clear	w	0.0	0.0	9
10	40	36	29.06	28.98	62	32	Cloudy	w	0.03	0.25	10
11	33	44	29.05	29.03	49	27	Clear	e	0.0	0.0	11
12	41	66	28.97	28.69	68	37	Pt. cloudy	s e	0.0	0.0	12
13	63	73	28.70	28.62	80	55	Clear	s w	0.0	0.0	13
14	66	73	28.73	28.62	81	60	Pt. cloudy	s	0.0	0.0	14
15	62	46	28.53	28.72	73	46	Cloudy	s	0.21	0.0	15
16	43	50	28.82	28.86	54	39	Pt. cloudy	s w	0.04	0.0	16
17	52	64	28.87	28.80	70	44	Cloudy	w	0.04	0.0	17
18	62	66	28.78	28.82	72	54	Pt. cloudy	w	0.03	0.0	18
19	58	48	28.88	28.93	66	48	Pt. cloudy	w	0.0	0.0	19
20	40	45	29.11	29.11	48	34	Clear	n	0.0	0.0	20
21	41	51	29.25	29.17	55	32	Clear	w	0.0	0.0	21
22	43	48	29.13	28.96	51	37	Cloudy	s	0.41	0.0	22
23	47	54	29.01	29.04	58	47	Cloudy	e	trace	0.0	23
24	48	58	29.11	29.02	58	43	Cloudy	e	0.0	0.0	24
25	53	50	28.93	28.65	58	47	Cloudy	s e	0.08	0.0	25
26	59	60	28.58	28.53	70	50	Cloudy	s e	0.35	0.0	26
27	38	43	28.67	28.93	60	34	Pt. cloudy	w	0.81	0.0	27
28	45	55	29.04	28.96	62	33	Clear	s w	0.0	0.0	28
29	57	63	28.95	28.91	69	44	Clear	w	0.0	0.0	29
30	53	57	28.99	28.97	67	45	Pt. cloudy	n	0.0	0.0	30
31	52	56	29.01	29.02	64	42	Pt. cloudy	e	0.0	0.0	31
Sum	1497	1653	897.63	896.18	1902	1273			2.22	0.25	
Average	48.3	53.3	28.96	28.91	61.4	41					

Meteorological observations for the month of June, 1907, at Agricultural College, East Lansing, Mich.

Day of month.	Thermometer in open air. 7 a. m.	Thermometer in open air. 7 p. m.	Barometer reduced to freezing point. 7 a. m.	Barometer reduced to freezing point. 7 p. m.	Registering thermometers. Maximum.	Registering thermometers. Minimum.	Character of day.	Prevailing wind direction.	Precipitation. Inches, rain or melted snow.	Precipitation. Snowfall, inches.	Day of month.
1	51	53	28.83	28.62	60	53	Cloudy	n e	0.03	0.0	1
2	51	56	28.66	28.80	62	49	Pt. cloudy	n e	0.05	0.0	2
3	55	63	28.77	28.71	68	41	Pt. cloudy	s	0.0	0.0	3
4	57	56	28.64	28.43	63	55	Cloudy	s w	0.32	0.0	4
5	50	58	28.55	28.78	64	48	Pt. cloudy	w	0.13	0.0	5
6	54	61	28.92	28.91	66	43	Clear	n w	0.0	0.0	6
7	54	55	28.93	28.89	62	42	Pt. cloudy	e	0.04	0.0	7
8	58	63	28.98	28.99	72	44	Clear	e	0.0	0.0	8
9	68	71	29.03	28.88	76	56	Clear	e	0.0	0.0	9
10	61	58	28.88	28.67	68	44	Cloudy	e	0.29	0.0	10
11	58	62	28.73	28.75	74	54	Cloudy	s	0.15	0.0	11
12	56	61	28.84	28.82	62	55	Cloudy	e	0.03	0.0	12
13	55	62	28.84	28.99	64	55	Cloudy	n e	0.13	0.0	13
14	74	77	29.19	29.47	83	49	Pt. cloudy	n w	0.0	0.0	14
15	63	72	29.49	29.25	82	57	Clear	n e	0.0	0.0	15
16	63	75	29.58	29.17	85	54	Pt. cloudy	w	0.0	0.0	16
17	72	81	29.78	28.95	86	63	Clear	w	0.0	0.0	17
18	72	80	29.07	29.15	90	66	Clear	w	0.0	0.0	18
19	67	71	29.59	28.96	80	62	Cloudy	n e	0.0	0.0	19
20	69	71	29.06	28.91	84	60	Pt. cloudy	n	0.01	0.0	20
21	74	74	29.01	28.97	84	64	Pt. cloudy	e	0.01	0.0	21
22	74	75	29.07	28.95	87	66	Pt. cloudy	s w	0.01	0.0	22
23	77	67	28.98	28.90	84	65	Pt. cloudy	s	0.90	0.0	23
24	69	74	28.90	28.87	80	67	Pt. cloudy	w	0.0	0.0	24
25	71	77	28.91	28.84	84	63	Clear	w	0.27	0.0	25
26	61	61	28.85	29.06	69	55	Clear	w	0.0	0.0	26
27	58	70	29.14	29.04	76	48	Clear	w	0.0	0.0	27
28	69	72	28.90	28.82	79	47	Pt. cloudy	e	0.0	0.0	28
29	69	70	28.81	28.75	80	56	Pt. cloudy	e	0.0	0.0	29
30	66	77	28.81	28.80	84	61	Pt. cloudy	w	0.0	0.0	30
Sum	1896	2023	869.74	867.10	2258	1642			2.37	0.0	
Average	63.2	67.4	28.99	28.90	75.3	54.7					

Meteorological observations for the month of July, 1907, at Agricultural College, East Lansing, Mich.

Day of month.	Thermometer in open air. 7 a. m.	Thermometer in open air. 7 p. m.	Barometer reduced to freezing point. 7 a. m.	Barometer reduced to freezing point. 7 p. m.	Registering thermometers. Maximum.	Registering thermometers. Minimum.	Character of day.	Prevailing wind direction.	Precipitation. Inches, rain and melted snow.	Precipitation. Snowfall inches.	Day of month.
1	66	72	28.72	28.80	80	66	Cloudy	w	0.13	0.0	1
2	54	66	29.06	29.08	72	53	Pt. cloudy	n	0.03	0.0	2
3	56	68	29.08	29.08	76	45	Pt. cloudy	w	0.0	0.0	3
4	62	75	29.01	29.01	81	59	Cloudy	s	0.05	0.0	4
5	68	77	29.06	28.82	77	65	Pt. cloudy	s w	0.05	0.0	5
6	70	80	28.80	28.87	81	69	Cloudy	n w	0.0	0.0	6
7	68	74	28.89	28.84	81	65	Pt. cloudy	w	0.0	0.0	7
8	72	74	28.84	28.86	83	60	Pt. cloudy	w	0.0	0.0	8
9	70	75	28.99	28.83	80	63	Pt. cloudy	w	0.0	0.0	9
10	67	75	28.99	28.83	84	65	Cloudy	e	0.0	0.0	10
11	60	61	28.73	28.77	74	61	Cloudy	n e	1.40	0.0	11
12	63	70	28.94	28.98	76	55	Clear	n	0.0	0.0	12
13	66	74	29.02	28.91	79	54	Clear	s	0.0	0.0	13
14	69	69	28.92	28.98	81	61	Pt. cloudy	e	0.0	0.0	14
15	72	77	28.77	28.72	79	65	Cloudy	s	0.68	0.0	15
16	73	79	28.90	28.89	84	67	Pt. cloudy	n w	0.10	0.0	16
17	77	77	28.93	29.08	85	70	Pt. cloudy	w	0.0	0.0	17
18	70	77	29.11	29.01	84	61	Clear	w	0.0	0.0	18
19	73	76	28.98	28.85	83	63	Pt. cloudy	w	0.0	0.0	19
20	68	75	28.87	29.81	82	65	Pt. cloudy	n	0.0	0.0	20
21	70	67	29.02	28.86	79	60	Cloudy	e	1.50	0.0	21
22	71	73	28.72	28.85	79	67	Pt. cloudy	n w	0.0	0.0	22
23	67	75	29.04	28.85	76	58	Pt. cloudy	w	0.0	0.0	23
24	67	78	28.80	28.76	85	66	Cloudy	w	0.14	0.0	24
25	69	76	28.83	28.62	83	62	Pt. cloudy	w	0.04	0.0	25
26	59	66	28.83	29.00	66	56	Clear	n	0.0	0.0	26
27	60	69	29.12	28.90	76	49	Clear	w	0.0	0.0	27
28	61	72	28.85	28.75	74	58	Pt. cloudy	w	0.0	0.0	28
29	69	70	28.78	28.84	77	60	Clear	n w	0.0	0.0	29
30	64	73	28.94	28.88	78	54	Clear	n w	0.0	0.0	30
31	64	70	28.82	28.80	80	60	Pt. cloudy	w	0.18	0.0	31
Sum	2065	2260	896.36	896.13	2455	1882			4.30	0.0	
Average	66.6	72.9	28.91	28.90	79.2	60.7					

Meteorological observations for the month of August, 1907, at Agricultural College, East Lansing, Mich.

Day of month.	Thermometer in open air.		Barometer reduced to freezing point.		Registering thermometers.		Character of day.	Prevailing wind direction.	Precipitation.		Day of month.
	7 a. m.	7 p. m.	7 a. m.	7 p. m.	Maximum.	Minimum.			Inches, rain and melted snow	Snowfall, inches.	
1	65	70	28.75	28.59	79	54	Pt. cloudy	w	0.0	0.0	1
2	61	59	28.73	28.87	59	51	Pt. cloudy	w	0.10	0.0	2
3	56	59	28.98	29.40	59	49	Cloudy	w	0.20	0.0	3
4	66	64	29.80	29.04	71	48	Clear	s	0.0	0.0	4
5	60	69	29.45	29.11	72	49	Pt. cloudy	w	0.55	0.0	5
6	65	75	29.77	29.84	78	41	Clear	w	0.0	0.0	6
7	73	78	29.42	29.06	83	53	Clear	w	1.50	0.0	7
8	63	68	29.19	29.64	79	56	Cloudy	n	0.0	0.0	8
9	64	79	29.08	29.60	84	50	Pt. cloudy	n	0.0	0.0	9
10	69	79	29.08	29.61	86	58	Clear	n	0.0	0.0	10
11	72	79	28.87	28.85	90	67	Clear	w	0.0	0.0	11
12	72	69	28.81	28.90	80	55	Clear	n	0.0	0.0	12
13	67	67	29.06	29.09	78	56	Clear	n	0.0	0.0	13
14	55	67	29.27	29.22	75	48	Pt. cloudy	e	0.0	0.0	14
15	68	76	29.17	28.96	76	66	Pt. cloudy	e	0.0	0.0	15
16	67	74	28.80	28.83	78	45	Pt. cloudy	w	0.28	0.0	16
17	67	73	28.97	29.01	81	64	Pt. cloudy	w	0.0	0.0	17
18	60	70	29.24	29.15	79	53	Clear	e	0.0	0.0	18
19	66	74	29.09	28.99	80	59	Cloudy	s	0.0	0.0	19
20	60	64	29.03	29.08	76	60	Cloudy	n	0.05	0.0	20
21	50	59	29.14	29.12	68	45	Clear	n	0.0	0.0	21
22	57	66	29.18	29.07	74	41	Clear	e	0.0	0.0	22
23	62	71	28.97	28.80	81	50	Clear	s	0.0	0.0	23
24	69	64	28.76	28.82	76	65	Clear	w	0.0	0.0	24
25	61	63	28.88	28.88	73	55	Clear	w	0.0	0.0	25
26	56	69	28.95	28.88	78	46	Clear	w	0.16	0.0	26
27	64	65	28.90	28.83	69	60	Cloudy	n e	0.0	0.0	27
28	60	67	28.94	28.97	70	60	Cloudy	n	0.0	0.0	28
29	63	69	28.99	28.90	74	59	Cloudy	w	0.03	0.0	29
30	69	74	28.90	28.98	83	66	Pt. cloudy	w	0.0	0.0	30
31	65	73	29.12	28.96	82	56	Clear	n w	0.0	0.0	31
Sum	1972	2153	901.29	901.05	2371	1691			2.87		
Average	63.6	69.4	29.07	29.06	76.5	54.5					

Meteorological observations for the month of September, 1907, at Agricultural College, East Lansing, Mich.

Day of month.	Thermometer in open air.		Barometer reduced to freezing point.		Registering thermometers.		Character of day.	Prevailing wind direction.	Precipitation.		Day of month.
	7 a. m.	7 p. m.	7 a. m.	7 p. m.	Maximum.	Minimum.			Inches, rain and melted snow.	Snowfall, inches.	
1	66	80	29.01	28.80	80	56	Cloudy	w	0.40	0.0	1
2	63	63	28.78	28.85	80	58	Pt. cloudy	w	0.64	0.0	2
3	53	63	28.84	28.89	83	70	Pt. cloudy	w	0.0	0.0	3
4	59	62	28.94	28.97	68	60	Cloudy	s w	0.02	0.0	4
5	55	60	28.99	29.04	76	54	Cloudy	w	0.07	0.0	5
6	55	65	29.93	29.05	73	43	Cloudy	w	0.70	0.0	6
7	60	64	28.99	28.93	70	59	Cloudy	s e	0.0	0.0	7
8	61	65	28.89	28.93	70	60	Cloudy	s e	0.15	0.0	8
9	59	61	29.06	29.03	71	56	Cloudy	w	0.09	0.0	9
10	53	61	29.08	28.77	70	54	Cloudy	w	0.0	0.0	10
11	56	57	28.79	28.84	62	52	Cloudy	w	0.23	0.0	11
12	57	66	29.06	29.11	75	56	Pt. cloudy	w	0.29	0.0	12
13	61	70	29.19	29.10	78	56	Clear	s w	0.02	0.0	13
14	63	71	29.11	29.06	80	57	Clear	s w	0.0	0.0	14
15	68	74	29.16	29.15	82	67	Pt. cloudy	w	0.0	0.0	15
16	69	71	29.07	28.99	82	67	Cloudy	w	0.0	0.0	16
17	60	65	29.08	29.03	72	59	Cloudy	n e	0.01	0.0	17
18	65	70	28.99	29.10	74	64	Cloudy	e	0.36	0.0	18
19	68	76	28.97	28.88	84	66	Pt. cloudy	s	0.10	0.0	19
20	71	66	28.78	28.83	77	67	Pt. cloudy	w	0.0	0.0	20
21	56	58	28.93	28.85	70	51	Clear	w	0.0	0.0	21
22	43	50	28.98	28.85	62	39	Clear	w	0.0	0.0	22
23	51	58	28.55	28.38	66	45	Cloudy	w	0.02	0.0	23
24	56	48	28.39	28.79	60	47	Pt. cloudy	w	0.23	0.0	24
25	42	44	29.07	29.20	48	39	Cloudy	w	0.03	0.0	25
26	39	51	29.19	29.09	56	33	Pt. cloudy	s w	0.0	0.0	26
27	50	50	28.98	28.89	52	48	Cloudy	s w	0.60	0.0	27
28	52	52	28.79	28.70	59	50	Cloudy	n	0.53	0.0	28
29	48	50	28.87	29.00	52	47	Pt. cloudy	n w	0.19	0.0	29
30	48	46	29.12	29.21	57	46	Clear	n w	0.0	0.0	30
Sum	1707	1837	869.58	868.21	2089	1626			4.68		
Average	56.9	61.2	28.99	28.94	69.6	54.2					

Meteorological observations for the month of October, 1907, at Agricultural College, East Lansing, Mich.

Day of month.	Thermometer in open air. 7 a. m.	Thermometer in open air. 7 p. m.	Barometer reduced to freezing point. 7 a. m.	Barometer reduced to freezing point. 7 p. m.	Registering thermometers. Maximum.	Registering thermometers. Minimum.	Character of day.	Prevailing wind direction.	Precipitation. Inches, rain and melted snow.	Precipitation. Snowfall, inches.	Day of month.
1	40	54	29.21	29.02	62	32	Pt. cloudy	s	0.0	0.0	1
2	54	64	28.95	28.93	78	48	Clear	s	0.0	0.0	2
3	60	66	28.93	28.70	70	53	Cloudy	s	0.82	0.0	3
4	55	50	28.80	28.79	66	50	Clear	w	0.0	0.0	4
5	48	50	28.81	28.93	59	45	Clear	w	0.0	0.0	5
6	48	59	28.88	28.69	66	40	Pt. cloudy	w	0.0	0.0	6
7	58	51	28.58	28.60	66	46	Pt. cloudy	w	0.26	0.0	7
8	36	43	29.05	29.10	55	33	Clear	n	0.0	0.0	8
9	44	50	28.98	28.81	60	38	Pt. cloudy	w	0.04	0.0	9
10	46	50	28.81	28.68	56	42	Pt. cloudy	w	0.04	0.0	10
11	43	43	28.72	28.90	50	36	Pt. cloudy	w	0.0	0.0	11
12	38	41	28.94	29.13	46	35	Cloudy	w	0.02	0.0	12
13	35	40	29.22	29.22	43	33	Cloudy	w	0.0	0.0	13
14	33	43	29.23	29.19	54	29	Clear	w	0.0	0.0	14
15	44	48	29.17	29.22	50	38	Cloudy	w	0.02	0.0	15
16	50	54	29.17	29.15	64	47	Pt. cloudy	s w	0.0	0.0	16
17	52	60	29.11	28.98	76	50	Clear	s w	0.0	0.0	17
18	40	39	29.20	29.29	59	40	Clear	n	0.0	0.0	18
19	35	45	29.19	29.08	48	35	Pt. cloudy	s	0.0	0.0	19
20	34	38	29.13	29.20	50	32	Pt. cloudy	s e	0.75	0.03	20
21	31	40	29.33	29.12	50	26	Clear	s	0.0	0.0	21
22	39	56	28.93	28.83	56	30	Pt. cloudy	w	0.0	0.0	22
23	39	38	28.99	29.11	54	34	Clear	w	0.0	0.0	23
24	32	40	29.13	28.94	52	28	Pt. cloudy	w	0.0	0.0	24
25	39	34	28.99	29.18	50	33	Clear	n w	0.0	0.0	25
26	27	40	29.21	28.95	43	23	Cloudy	n w	0.0	0.0	26
27	40	38	28.72	28.91	43	38	Cloudy	n w	0.27	0.0	27
28	33	36	29.06	29.09	42	32	Pt. cloudy	w	0.0	0.0	28
29	29	39	29.08	29.16	52	28	Clear	w	0.0	0.0	29
30	31	37	29.28	29.33	46	28	Pt. cloudy	e	0.0	0.0	30
31	34	46	29.32	29.23	54	30	Cloudy	e	0.0	0.0	31
Sum	1698	1432	900.12	899.46	1720	1130			2.22	0.03	
Average	54.7	46.2	29.03	29.01	55.5	36.5					

Meteorological observations for the month of November, 1907, at Agricultural College, East Lansing, Mich.

Day of month.	Thermometer in open air.		Barometer reduced to freezing point.		Registering thermometers.		Character of day.	Prevailing wind direction.	Precipitation.		Day of month.
	7 a. m.	7 p. m.	7 a. m.	7 p. m.	Maximum.	Minimum.			Inches, rain and melted snow.	Snowfall, inches.	
1	41	48	29.08	28.73	54	41	Cloudy	s e	0.21	0.0	1
2	50	44	28.42	28.59	50	40	Cloudy	w	0.39	0.0	2
3	40	39	28.74	28.89	50	33	Pt. cloudy	n w	0.0	0.0	3
4	37	42	28.90	28.75	46	30	Cloudy	w	0.0	0.0	4
5	39	42	28.69	28.62	50	33	Cloudy	w	0.17	0.0	5
6	34	36	29.65	28.79	42	33	Cloudy	n w	0.07	trace	6
7	34	36	28.85	28.84	44	31	Cloudy	n w	0.0	0.0	7
8	36	36	28.80	28.88	47	31	Pt. cloudy	w	0.0	0.0	8
9	34	38	28.70	28.71	46	29	Cloudy	w	0.0	0.0	9
10	34	33	28.79	28.94	38	30	Cloudy	w	0.15	trace	10
11	23	29	28.13	29.23	36	20	Pt. cloudy	w	0.0	0.0	11
12	28	31	29.29	29.19	36	27	Pt. cloudy	n	0.0	0.0	12
13	32	33	28.97	28.97	35	26	Cloudy	n w	0.0	0.0	13
14	20	26	29.21	29.12	33	17	Clear	w	0.0	0.0	14
15	27	28	29.11	29.19	36	21	Pt. cloudy	w	0.0	0.0	15
16	20	35	29.23	29.17	41	18	Clear	w	0.0	0.0	16
17	31	37	29.18	29.17	45	30	Clear	w	0.0	0.0	17
18	37	40	29.02	29.09	52	35	Pt. cloudy	s w	0.0	0.0	18
19	35	38	29.20	29.22	40	31	Cloudy	n e	0.0	0.0	19
20	38	44	29.06	28.48	44	33	Cloudy	e	0.60	0.0	20
21	41	41	28.64	28.92	49	40	Cloudy	s w	0.10	0.0	21
22	39	34	29.08	29.18	43	33	Pt. cloudy	w	0.0	0.0	22
23	27	34	29.27	29.26	42	23	Clear	e	0.0	0.0	23
24	30	35	29.47	29.18	42	36	Clear	e	0.0	0.0	24
25	31	42	29.06	29.76	49	28	Cloudy	s	0.10	0.0	25
26	33	34	28.89	29.05	42	29	Pt. cloudy	w	0.0	0.0	26
27	31	45	28.98	28.63	48	28	Pt. cloudy	s w	0.01	0.0	27
28	37	35	29.00	29.08	45	18	Cloudy	w	0.0	0.0	28
29	29	29	29.20	29.12	35	27	Cloudy	w	0.0	trace	29
30	29	30	29.06	29.01	31	27	Cloudy	w	0.03	0.30	30
Sum	997	1094	869.67	869.76	1291	868			1.83	0.30	
Average	33.2	36.4	28.98	28.99	43.0	28.9					

Meteorological observations for the month of December, 1907, at Agricultural College, East Lansing, Mich.

Day of month.	Thermometer in open air.		Barometer reduced to freezing point.		Registering thermometers.		Character of day.	Prevailing wind direction.	Precipitation.		Day of month.
	7 a. m.	7 p. m.	7 a. m.	7 p. m.	Maximum.	Minimum.			Inches rain and melted snow.	Snowfall, inches.	
....	28	22	29.09	29.05	31	20	Cloudy.....	n w	0.0	trace	1
....	20	25	29.13	28.97	26	17	Cloudy.....	n w	0.02	0.25	2
....	25	23	28.92	29.13	28	18	Pt. cloudy..	n e	0.10	1.00	3
....	11	16	29.34	29.34	26	10	Clear	n w	0.0	0.0	4
....	20	27	29.21	29.03	30	11	Clear.......	s w	0.0	0.0	5
....	23	30	29.00	29.04	38	21	Clear.......	s w	0.0	0.0	6
....	28	42	29.07	28.98	50	28	Pt. cloudy..	s w	0.0	0.0	7
....	40	49	28.92	28.86	48	38	Cloudy.....	s	0.11	0.0	8
....	42	49	28.66	28.36	50	42	Cloudy.....	s e	0.92	0.0	9
0............	25	22	28.47	28.77	49	20	Cloudy.....	n	0.05	0.50	10
1............	19	25	28.81	28.86	25	18	Cloudy.....	n w	0.0	0.0	11
2............	22	20	29.02	29.12	28	15	Pt. cloudy..	w	0.0	0.0	12
3............	16	28	29.14	28.99	28	13	Pt. cloudy..	w	0.0	0.0	13
4............	28	29	28.59	28.55	35	23	Cloudy.....	n e	0.60	6.00	14
5............	29	26	28.54	28.66	29	23	Cloudy.....	n w	0.30	3.00	15
6............	26	27	28.73	28.94	26	25	Cloudy.....	w	0.0	0.0	16
7............	13	26	29.07	29.04	27	12	Pt. cloudy..	w	0.05	0.50	17
8............	25	24	28.96	28.89	28	22	Cloudy.....	n w	0.02	0.25	18
9............	22	22	29.09	29.03	24	21	Pt. cloudy..	w	0.0	0.0	19
0............	22	29	29.00	29.11	26	23	Clear.......	s w	0.0	0.0	20
1............	26	22	29.31	29.29	33	23	Cloudy.....	s w	0.0	0.0	21
2............	24	30	29.11	28.91	33	23	Cloudy.....	s	0.0	0.0	22
3............	28.5	31	28.46	28.32	33	23	Cloudy.....	n e	1.42	8.00	23
4............	29	22	28.57	28.71	33	20	Cloudy.....	w	0.0	0.0	24
5............	32.5	30	28.55	29.00	35	17	Pt. cloudy..	s w	0.30	3.00	25
6............	25	39	29.11	28.77	39	18	Cloudy.....	s	trace	0.0	26
7............	40	44	28.61	28.66	47	44	Cloudy.....	s	0.0	0.0	27
8............	30	25	28.94	29.10	44	25	Cloudy.....	n	0.0	0.0	28
9............	26	32	29.06	28.72	33	21	Cloudy.....	n e	trace	0.0	29
0............	32.5	25	28.34	28.96	33	25	Cloudy.....	w	0.30	3.00	30
1............	19	30	29.10	29.09	32	15	Cloudy.....	s w	0.0	0.0	31
um..........	796.5	891	895.92	896.25	10.47	674	....	....	4.19	25.50	....
verage.......	25.6	28.7	28.90	28.79	33.8	21.7	....	....	....	......	....

BULLETINS

OF THE

AGRICULTURAL COLLEGE EXPERIMENT STATION

ISSUED DURING THE

YEAR ENDING JUNE 30, 1908.

EXPERIMENT STATION BULLETINS.

FERTILIZER ANALYSES.

BY ANDREW J. PATTEN.

Bulletin No. 248.

The inspection and analyses of the commercial fertilizers offered f sale in Michigan are made under authority of an act of the Legislatu approved March 10, 1885. The full text of the law has been print in former bulletins, and its salient points alone will be referred to he It provides that all commercial fertilizers, retailing for more than t dollars per ton, shall be accompanied by a statement certifying t number of net pounds in the given sack, the brand, name and addre of the manufacturer, and a chemical analysis stating the percentag of nitrogen, of potash soluble in water, of available (soluble and verted) phosphoric acid, and the insoluble phosphoric acid. (Sec. 1 It provides that the manufacturer, importer or agent (the latter on in case the manufacturer fails to comply with the law), shall pay a nually a license fee of twenty dollars for each brand offered for sale. (Se 3.) It provides that any person offering unguaranteed or over-guara teed goods, shall be subject to a fine. (Sec. 6.) The full text will furnished on application.

LICENSED BRANDS.

Twenty-six manufacturers and fertilizer companies have licensed 1 distinct brands for sale in the state during the season of 1907. The brands, appearing in the following tables of analyses, and no others c be legally sold.

Parties manufacturing, importing or purchasing fertilizers for the own use and not for sale are not affected by the restrictions of t law.

COLLECTION OF SAMPLES.

The sampling agent of the station, during the months of April, Ma and June drew 193 samples from dealers stock, representing 119 differe brands. The failure to get samples of 26 brands is due to the fa that many of them are sold only in the fall, then too, a few companies se direct to the consumer through the Grange and other organizatio and consequently, it is only by chance that samples of these goods a obtained. If persons ordering goods in this way wish to have the inspected they will protect themselves and at the same time confer

favor on this department by notifying us, and upon the arrival of the goods an inspector will be sent to draw samples.

It is the desire of this department to make the inspection as complete as possible and any information to further this end from dealer or consumer would be greatly appreciated. In all cases of failure to find a brand on the market, the analyses were made on the manufacturer's sample as indicated in the tables of analyses.

RESULTS OF INSPECTION.

A study of the tables of analyses following shows that of the 177 samples analyzed, representing 145 brands, 77 (44%) as below guarantee* in one or more constituents. Fifty-one (29%) are below guarantee in nitrogen, 14 (21%) in available phosphoric acid and 40 (23%) in potash. Twenty-one (12%) are below guarantee in nitrogen and potash, 12 (7%) in nitrogen and available phosphoric acid, 9 (5%) in potash and available phosphoric acid and 7 (4%) in nitrogen, available phosphoric acid and potash.

Nineteen brands (13%) fail to furnish a commercial equivalent of the constituents guaranteed. Of these, nine are sold by the Buffalo Fertilizer Company and three by the Chicago Fertilizer Co. The other seven brands failing to furnish a commercial equivalent are distributed among six companies. The facts revealed by the analyses of the goods of the Buffalo Fertilizer Co., and the Chicago Fertilizer Co., demand that special attention be called to them.

Buffalo Fertilizer Co.: It is a significant fact that the only brand sold by this company which furnished a commercial equivalent was Muriate of Potash a material not manufactured by the company.

Ammoniated Bone Black. Three samples of this brand were drawn from different localities all of which were quite similar in appearance. Sample 1340 is below guarantee in nitrogen and above in available phosphoric acid and potash. Sample 1485 furnishes a little more than one-half of the nitrogen, a little better than three-fourths of the available phosphoric acid and a trifle more than the potash guaranteed. Sample 1503 furnishes three-fourths of the nitrogen guaranteed and is hardly up to the requirements for available phosphoric acid and potash.

Bone Meal. Only one sample of this brand was found on the markets. It is more than one per cent below guarantee in nitrogen and just meets the guarantee for phosphoric acid. It fails to furnish a commercial equivalent.

Celery and Potato Special. Four samples of this brand were drawn from different localities, no two of which are alike either in physical appearance or chemical analyses. Sample 1398 furnishes a trifle more than two-thirds of the nitrogen, a little better than three-fourths of the available phosphoric acid and a little more than four-fifths of the potash guaranteed. Sample 1486 furnishes less than one-half of the nitrogen, a little more than five-eighths of the available phosphoric acid and a trifle more than one-half of the potash guaranteed. Sample 1487 furnishes seven-tenths of the potash guaranteed and is above in available phosphoric acid. Sample 1488 furnishes a little more than two-thirds

* A shortage of 0.10 per cent. or more of nitrogen, or of 0.20 per cent. or more of available phosphoric acid or potash is considered below guarantee.

of the nitrogen, one per cent more available phosphoric acid and less than one-half of the potash guaranteed. None of these samples furnish a commercial equivalent.

Farmers Choice. Five samples of this brand were drawn, two being taken from the same shipment, the other three from different localities. Two of the five samples are a little above guarantee in nitrogen, the other three samples furnishing about three-fourths of the amount guaranteed. Three of the samples barely meet the guarantee and two are below in available phosphoric acid. All five samples are below guarantee in potash. The average analysis fails to furnish a commercial equivalent.

Garden Truck. Three samples of this brand were drawn from different localities. Sample 1494 furnishes five-sixths of the nitrogen, seven-eighths of the available phosphoric acid and barely meets the guarantee for potash. The nitrogen is mostly in the form of nitrate. Sample 1493 furnishes a trifle more than one-third of the nitrogen, seven-eighths of the available phosphoric acid guaranteed and barely meets the guarantee for potash. None of the nitrogen in this sample is in the form of nitrate. Sample 1341 furnishes a little more than three-eighths of the nitrogen guaranteed and is below in both available phosphoric acid and potash. None of the nitrogen is in the form of nitrate. This brand does not furnish a commercial equivalent.

General Crop. Four samples of this brand were taken from different localities. Sample 1399 is a trifle above the guarantee for available phosphoric acid and slightly below in potash. Sample 1504 is a little over two per cent above guarantee for available phosphoric acid and one per cent below in potash. Sample 1505 is nearly one per cent below in available phosphoric acid and a trifle above in potash. Sample 1506 is one and a half per cent below guarantee in available phosphoric acid and nearly one per cent below in potash. This brand does not furnish a commercial equivalent.

Ohio and Michigan Special. Only one sample of this brand was found on the markets. It furnishes seven-eighths of the nitrogen, a little more than one-half of the available phosphoric acid and nearly two and one-half times the amount of potash guaranteed. This brand does not furnish a commercial equivalent.

Soluble Bone. Only one sample of this brand was found on the markets. It does not furnish a commercial equivalent.

York State Special. Two samples of this brand were drawn in different localities. Sample 1342 furnishes one-half of the nitrogen, a trifle less than seven-ninths of the available phosphoric acid and a half per cent more potash than guaranteed, a part of its nitrogen is in the form of nitrate. Sample 1496 furnishes a very little more than one-half of the nitrogen, a half per cent less available phosphoric acid and a half per cent less potash than guaranteed, and contains no nitrate nitrogen. This brand fails to furnish a commercial equivalent.

Chicago Fertilizer Co.: This company licensed three brands all of which were below in nitrogen, one sample, 1411, furnishing five-eighths of the amount guaranteed while the other samples, 1438 and 1439, furnished less than one-half of the amount guaranteed. Two of the samples are below guarantee in available phosphoric acid and one in potash. Neither of the brands sold by this company furnish a commercial equivalent.

PRICES USED IN VALUATION OF FERTILIZERS.

In determining the commercial valuation of fertilizers the following schedule of prices has been used: Nitrogen in mixed fertilizers 20½ cents per pound, in nitrates 18½ cents per pound; potash soluble in water 5 cents per pound; available phosphoric acid 5 cents per pound; total phosphoric acid in bone 4 cents per pound; insoluble phosphoric acid in mixed fertilizers containing nitrogen 2 cents per pound; in fertilizers containing no nitrogen no value is given to insoluble phosphoric acid.

A valuation is determined as follows: The percentage or pounds per hundred of each ingredient (nitrogen, available phosphoric acid, insoluble phosphoric acid and potash) are multiplied by 20, giving the number of pounds of each ingredient in a ton. The figures are then multiplied by their respective pound prices.

It should be clearly borne in mind that, in publishing these prices, the station does not assume to dictate the price at which fertilizers shall be sold. Owing to the fluctuation in prices, differences in cost of delivery at different points, and other causes, the obtaining of true average market prices is an impossibility. The schedule of prices has been used by the station simply as a means of comparing the value of fertilizers as guaranteed by the manufacturer with the value of the samples as collected in the open market. Purchasers will often find these prices of use in comparing the relative values of similar brands offered by different manufacturers.

ACKNOWLEDGMENT.

I desire to acknowledge the efficient assistance of Miss Dorothea Moxness and Mr. C. B. Collingwood by whom the greater part of the analytical work herein reported was performed.

Results of analyses of commercial fertilizers for

Laboratory number.	Manufacturer and Trade Name.	Nitrogen.	
		Found.	Guaranteed.
	THE AMERICAN AGRICULTURAL CHEMICAL CO., NEW YORK, N. Y.:		
1461	Bradley's Alkaline Bone with Potash	....	....
1387	Bradley's B. D. Sea Fowl Guano	2.28	2.06
1386	Bradley's Dissolved Bone with Potash	1.19	1.0
1414	Bradley's Niagara Phosphate	0.79	0.82
1415	Bradley's Soluble Dissolved Bone	....	....
1458	Bradley's Special Potash Fertilizer	0.85	0.82
1351	Crocker's Ammoniated Wheat and Corn Phosphate	2.18	2.05
1468	Crocker's Ammoniated Bone Superphosphate	**2.26**	2.46
1391	Crocker's Dissolved Bone and Potash	....	....
1417	Crocker's General Crop Phosphate	0.93	0.82
1354	Crocker's New Rival Ammoniated Superphosphate	1.21	1.23
1353	Crocker's Universal Grain Grower	0.81	0.82
1356	Fine Ground Bone	2.47	2.46
1352	High Grade Garden and Vegetable Fertilizer	2.13	2.0
1510	High Grade Garden and Vegetable Fertilizer	**1.77**	2.0
1355	New York State Special	0.84	0.82
1433	Niagara Dissolved Bone and Potash	....	....
1429	Niagara Grain and Grass Grower	0.89	0.82
1416	Niagara Potato and Vegetable Fertilizer	2.12	2.05
1434	Niagara Wheat and Corn Producer	1.22	1.23
	THE ARMOUR FERTILIZER WORKS, CHICAGO, ILL.:		
1444	All Soluble	3.43	2.88
1452	Ammoniated Bone with Potash	**2.17**	2.47
1459	Banner Brand	....	....
1390	Bean Grower	1.24	0.82
1367	Bone, Blood and Potash	4.13	4.11
1366	Bone Meal	**1.99**	2.47
1348	Crop Grower	**0.89**	1.23
1511	Crop Grower	1.21	1.23
1512	Crop Grower	1.31	1.23
1437	Fruit and Root Crop Special	**1.51**	1.65
1513	Fruit and Root Crop Special	**1.45**	1.65
1448	German Kainit	....	....
1347	Grain Grower	**1.34**	1.65
1514	Grain Grower	**1.55**	1.65
1515	Grain Grower	**1.49**	1.65
1369	High Grade Potato	**1.58**	1.65
1516	High Grade Potato	**1.48**	1.65
1465	Muriate of Potash	....	....
1456	Nitrate of Soda	15.80	15.63
1403	Phosphate and Potash	....	....
1446	Star Phosphate	....	....
1445	Steamed Bone Meal	2.78	1.65
1346	Sugar Beet Special	0.89	0.82
1517	Sugar Beet Special	0.82	0.82
1518	Sugar Beet Special	0.81	0.82
1349	Wheat, Corn and Oat Special	0.97	0.82
	BASH PACKING CO., FORT WAYNE, IND.:		
1454	Bash's Corn and Wheat Grower	**1.64**	2.0
1484	*Bash's Grain Grower	1.34	1.20
1455	Bash's Potato and Garden Special	**1.10**	2.20

*Manufacturers' samples.

07, expressed in parts in one hundred.

Phosphoric acid.						Potash.	
Total.		Insoluble.		Available.			
Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
13.90	12.0	0.66	....	13.24	6.0	1.83	2.0
11.53	....	2.43	2.0	9.10	8.0	1.82	1.50
11.33	10.0	2.24	2.0	9.09	8.0	2.07	2.0
9.26	8.0	1.08	1.0	8.18	7.0	1.19	1.0
17.06	15.0	1.47	1.0	15.59	14.0	....	....
10.76	10.0	1.48	....	9.28	8.0	3.25	3.0
11.61	10.0	1.97	1.0	9.64	8.0	1.48	1.50
12.01	10.0	1.85	1.0	10.16	9.0	3.23	2.0
11.78	11.0	0.87	1.0	10.91	10.0	2.44	2.0
10.63	....	2.17	1.0	8.46	7.0	1.14	1.0
11.82	....	1.77	1.0	10.05	9.0	2.09	2.0
10.71	9.0	1.58	1.0	9.13	8.0	1.98	2.0
28.98	20.0	....	....	....	....	....	....
10.87	10.0	0.98	....	9.89	8.0	6.00	6.0
10.27	10.0	0.64	....	9.63	8.0	5.15	6.0
10.96	10.0	1.41	....	9.55	8.0	3.15	3.0
12.67	11.0	1.96	1.0	10.71	10.0	1.81	2.0
10.35	....	1.27	1.0	9.08	7.0	1.09	1.0
10.89	....	1.78	1.0	9.11	8.0	3.37	3.0
12.15	....	1.58	1.0	10.57	9.0	2.12	2.0
13.47	....	1.77	2.0	11.70	8.0	4.70	4.0
12.06	....	2.08	2.0	9.98	6.0	2.58	2.0
13.01	....	0.22	2.0	12.79	10.0	7.80	8.0
11.71	....	2.31	2.0	9.40	8.0	2.44	2.0
12.22	....	2.30	2.0	9.92	8.0	8.53	7.0
30.08	24.0	....	....	....	....	....	....
10.92	....	0.95	2.0	9.97	8.0	2.37	2.0
12.07	....	1.56	2.0	10.51	8.0	1.86	2.0
11.70	....	1.56	2.0	10.14	8.0	1.80	2.0
10.31	....	0.67	2.0	9.64	8.0	4.63	5.0
9.52	....	0.51	2.0	9.01	8.0	4.72	5.0
....	....	....	....	....	....	11.93	12.0
11.34	....	1.10	2.0	10.24	8.0	1.80	2.0
12.40	....	3.14	2.0	9.26	8.0	2.08	2.0
12.27	....	1.30	2.0	10.97	8.0	1.83	2.0
11.30	....	1.04	2.0	10.26	8.0	10.82	10.0
12.70	....	2.32	2.0	10.38	8.0	9.18	10.0
....	....	....	....	....	....	51.81	48.0
....	....	....	....	....	....	....	....
12.27	....	0.16	2.0	12.11	10.0	2.64	2.0
18.22	....	0.81	2.0	17.41	14.0	....	....
26.37	20.0	....	....	....	....	....	....
10.49	....	1.00	2.0	9.49	8.0	3.93	4.0
9.92	....	0.37	2.0	9.55	8.0	2.71	4.0
10.90	....	0.74	2.0	10.16	8.0	3.93	4.0
9.48	....	0.91	2.0	8.57	7.0	1.10	1.0
7.05	....	0.28	1.0	6.77	5.0	1.46	2.0
10.27	....	0.55	1.0	9.72	8.0	2.17	2.0
7.96	....	0.22	1.0	7.74	8.0	7.98	10.0

Results of analyses of commercial fertilizers f

Laboratory number.	Manufacturer and Trade Name.	Nitrogen.	
		Found.	Guar-anteed.
	ROBERT BINDER, BATTLE CREEK, MICH.:		
1392	Blood and Bone	5.34	5.
	THE JAMES BOLAND FERTILIZER CO., JACKSON, MICH.:		
1382	Blackman General Crop	2.53	1.
1381	Sugar Beet, Onion and Potato	2.41	2.
	THE BUFFALO FERTILIZER CO., BUFFALO, N. Y.:		
1340	Ammoniated Bone Black	**1.04**	1.
1485	Ammoniated Bone Black	**0.70**	1.
1503	Ammoniated Bone Black	**0.91**	1.
1343	Bone Meal	**1.55**	2.
1398	Celery and Potato Special	**1.16**	1.
1486	Celery and Potato Special	**0.65**	1.
1487	Celery and Potato Special	**1.28**	1.
1488	Celery and Potato Special	**1.19**	1.
1400	Farmers' Choice	**0.60**	0.
1489	Farmers' Choice	0.97	0.
1490	Farmers' Choice	0.87	0.
1491	Farmers' Choice	**0.65**	0.
1492	Farmers' Choice	**0.65**	0.
1341	Garden Truck	**1.38**	3.
1493	Garden Truck	**1.14**	3.
1494	Garden Truck	**2.71**	3.
1399	General Crop	....	....
1504	General Crop	....	....
1505	General Crop	....	....
1506	General Crop	....	....
1344	Muriate of Potash	....	....
1432	Ohio and Michigan Special	**0.71**	0.
1466	Soluble Bone	....	....
1342	York State Special	**0.84**	1.
1496	York State Special	**0.88**	1.
	E. BURTON, ST. JOSEPH, MICH.:		
1404	Meat and Bone Phosphate	4.66	3.
	CHICAGO FERTILIZER CO., CHICAGO, ILL.:		
1411	Blood, Bone and Potash	**0.70**	1.
1438	Potash Special	**0.81**	0.
1439	Wheat and Corn Special	**0.34**	0.
	THE CINCINNATI PHOSPHATE CO., CINCINNATI, O.:		
1499	*Capitol Dissolved Bone and Potash	....	....
1500	*Capitol Grain and Grass Grower	1.41	1.
1501	*Capitol Tobacco, Potato and Beet Grower	0.94	0.
1502	*Capitol Wheat Grower	....	....
	DARLING & CO., UNION STOCK YARDS, CHICAGO, ILL.:		
1469	*Darling's Acid Phosphate	....	....
1412	Darling's Chicago Brand	1.79	1.
1378	Darling's Farmers' Favorite Brand	2.72	2.
1377	Darling's General Crop Brand	0.92	0.
1519	Darling's General Crop Brand	0.90	0.
1470	*Darling's Pure Bone and Potash	2.44	2.
1413	Darling's Pure Ground Bone	2.90	2.
1375	Darling's Sure Winner Brand	1.04	0.
1423	Darling's Vegetable and Lawn Fertilizer	3.64	3.
1376	Darling's Western Brand	0.59	0.
1507	Darling's Western Brand	0.52	0.

* Manufacturers' samples.

1907, expressed in parts in one hundred.

Phosphoric acid.						Potash.	
Total.		Insoluble.		Available.			
Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
15.11	13.17	....	....	....	....	0.33	0.29
16.96	....	12.50	9.0	**4.46**	6.0	1.27	1.25
17.47	....	10.45	6.0	**7.02**	9.0	2.08	2.0
9.15	....	0.72	1.0	8.43	8.0	2.88	2.50
6.97	....	0.55	1.0	**6.42**	8.0	2.53	2.50
9.55	....	1.66	1.0	7.89	8.0	2.31	2.50
22.08	22.0	....	....	....	....	....	....
7.62	....	1.22	1.0	**6.40**	8.0	**8.36**	10.0
5.82	....	0.62	1.0	**5.20**	8.0	**5.14**	10.0
9.66	....	1.00	1.0	8.66	8.0	**7.02**	10.0
10.45	....	1.35	1.0	9.10	8.0	**4.46**	10.0
8.43	....	0.45	1.0	7.98	8.0	**4.09**	5.0
8.88	....	0.85	1.0	8.03	8.0	**3.14**	5.0
7.42	....	0.57	1.0	**6.85**	8.0	**4.56**	5.0
8.30	....	0.78	1.0	**7.52**	8.0	4.90	5.0
8.83	....	0.87	1.0	7.96	8.0	**4.43**	5.0
8.05	....	0.40	1.0	**7.65**	8.0	**6.36**	7.0
9.42	....	1.10	1.0	8.32	8.0	**6.02**	7.0
7.82	....	0.92	1.0	**6.90**	8.0	6.96	7.0
11.15	....	1.90	1.0	9.25	9.0	2.89	3.0
12.12	....	0.94	1.0	11.18	9.0	**1.96**	3.0
9.08	....	0.84	1.0	**8.24**	9.0	3.08	3.0
8.82	....	1.37	1.0	**7.45**	9.0	**2.14**	3.0
....	....	....	....	....	....	48.12	48.0
7.00	....	1.35	1.0	**5.65**	10.0	2.39	1.0
16.02	....	3.04	1.0	**12.98**	14.0	....	....
7.57	....	0.72	1.0	**6.85**	9.0	5.48	5.0
9.31	....	0.77	1.0	**8.54**	9.0	**4.49**	5.0
14.63	15.0	....	....	....	....	0.24	0.36
11.12	....	3.53	....	**7.59**	8.0	1.92	2.0
11.07	....	4.32	....	**6.75**	8.0	**0.93**	4.0
9.72	....	2.66	....	7.06	7.0	1.14	1.0
14.10	11.0	0.65	....	13.45	10.0	**2.79**	4.0
11.78	9.0	1.90	....	9.88	8.0	3.68	2.0
9.05	9.0	1.37	....	**7.68**	8.0	4.86	4.0
17.85	15.0	3.28	....	14.57	14.0	....	....
12.47	....	0.53	....	11.94	10.0	....	....
13.70	10.0	3.21	....	10.49	8.0	2.86	2.0
13.80	10.0	4.63	....	9.17	8.0	4.84	4.0
10.88	10.0	0.98	....	9.90	8.0	6.15	6.0
11.00	10.0	1.00	....	10.00	8.0	**4.47**	6.0
23.02	20.13	....	....	....	....	7.03	6.0
27.35	23.0	....	....	....	....	....	....
10.10	10.0	0.94	....	9.16	8.0	3.54	3.0
10.60	9.0	2.16	....	8.44	8.0	7.37	7.0
7.39	9.0	0.42	....	6.97	7.0	1.26	0.50
8.97	9.0	0.32	....	8.65	7.0	1.07	0.50

Results of analyses of commercial fertili

Laboratory number.	Manufacturer and Trade Name.	Nitrogen. Found.	Nitrogen. Guar- antee
	GLEANER CLEARING HOUSE ASSOCIATION, DETROIT, MICH.:		
1526	*Gleaner Acid Phosphate	......	......
1527	*Gleaner Favorite	2.67	1
1528	*Gleaner General Grower	1.85	0
1529	*Gleaner Phosphate and Potash	......	......
1530	*Gleaner Special	1.85	0
	GRAND RAPIDS GLUE CO., GRAND RAPIDS, MICH.:		
1345	Grand Rapids	2.46	2
	GRANGE FERTILIZER CO., DETROIT, MICH.:		
1463	Michigan Grange All Crops Special	1.06	1
1471	*Michigan Grange Complete Fertilizer	0.87	0
1428	Michigan Grange Corn, Oats and Grass	1.57	1
1427	Michigan Grange Potato and Vegetable Fertilizer	0.95	0
1520	Michigan Grange Potato and Vegetable Fertilizer	0.91	0
1472	*Michigan Grange Wheat Fertilizer	......	......
1443	Michigan Grange Wheat Fertilizer with Potash	......	......
	THE JARECKI CHEMICAL CO., SANDUSKY, O.:		
1464	C. O. D. Phosphate	......	......
1407	Fish and Potash Potato and Tobacco Food	0.82	0
1508	Fish and Potash Potato and Tobacco Food	0.79	0
1406	Lake Erie Fish Guano	0.92	1
1462	Little Giant Guano	0.86	0
1419	Number One Fish Guano	0.86	1
1509	Number One Fish Guano	1.08	1
1460	Special Sugar Beet Grower	0.85	0
1405	Square Brand Phosphate and Potash	......	......
1420	Tobacco and Truck Grower	1.31	1
	KALAMAZOO RENDERING AND FERTILIZER CO., KALAMAZOO, MICH.:		
1393	Kazoo Fertilizer	2.02	5
	MICHIGAN CARBON WORKS, DETROIT, MICH.:		
1397	A-1 Potash	1.00	0
1473	*Banner Dissolved Bone	......	......
1368	Homestead, a Bone Black Fertilizer	2.14	2
1396	Homestead High Grade Garden and Vegetable Fertilizer	2.18	2
1418	Homestead Potato and Tobacco Fertilizer	2.25	2
1425	Homestead Special Beet Fertilizer	1.68	1
1424	Homestead Sugar Beet Fertilizer	1.24	1
1421	Red Line Complete Manure	0.88	0
1474	*Red Line Phosphate	......	......
1447	Red Line Phosphate with Potash	......	......
	NORTH WESTERN FERTILIZING CO., CHICAGO, ILL.:		
1475	*Acidulated Bone and Potash	0.94	0
1372	Garden City Superphosphate	2.46	2
1370	Horse Shoe Corn and Wheat Grower	1.61	1
1373	Horse Shoe High Grade Garden and Vegetable Fertilizer	2.15	2
1385	Horse Shoe Potash Manure	0.99	0
1394	Horse Shoe Potato Grower	2.49	2
1374	Horse Shoe Sugar Beet Fertilizer	1.26	1
1436	Quick Acting Phosphate	......	......

* Manufacturers' sample.

for 1907, expressed in parts in one hundred.

Phosphoric acid.						Potash.	
Total.		Insoluble.		Available.			
Found.	Guar-anteed.	Found.	Guar-anteed.	Found.	Guar-anteed.	Found.	Guar-anteed.
18.80	....	1.59	1.0	17.21	14.0	....	....
10.07	....	0.97	1.0	9.10	8.0	8.56	4.0
11.90	....	1.04	1.0	10.86	10.0	3.74	1.0
12.50	....	1.10	1.0	11.40	10.0	2.59	2.0
10.45	....	1.20	1.0	9.25	8.0	6.86	4.0
17.63	15.0	7.58	....	10.05	8.0	0.82	1.0
10.30	....	0.97	2.0	9.33	8.0	2.07	2.0
9.70	....	1.16	1.0	8.54	7.0	1.17	1.0
11.08	....	1.02	2.0	10.06	8.0	1.93	2.0
11.35	....	1.36	....	9.99	8.0	3.87	4.0
10.30	....	0.99	....	9.31	8.0	4.02	4.0
17.30	....	0.94	1.0	16.36	14.0	....	....
12.46	....	0.84	1.0	11.62	10.0	2.43	2.0
17.25	....	0.83	1.0	16.42	14.0	....	....
9.92	....	0.94	1.0	8.98	8.0	**3.56**	4.0
8.97	....	0.95	1.0	8.02	8.0	**3.80**	4.0
11.78	....	1.76	1.0	10.02	8.0	3.40	2.50
10.11	....	0.57	1.0	9.54	7.0	1.13	1.0
10.20	....	1.12	1.0	9.08	8.0	**1.52**	2.0
10.20	....	0.72	1.0	9.48	8.0	2.18	2.0
9.34	....	0.74	1.0	8.60	8.0	**3.36**	4.0
13.15	....	1.51	1.0	11.64	10.0	2.16	2.0
11.26	....	1.34	1.0	9.92	6.0	**4.89**	6.0
13.17	....	8.99	3.0	4.18	3.0	5.81	4.0
11.32	....	1.29	....	10.03	8.0	3.05	3.0
37.55	....	0.68	....	36.87	30.0	....	....
9.88	....	0.98	....	8.90	8.0	1.64	1.50
10.68	....	0.94	....	9.74	8.0	6.57	6.0
10.60	....	1.26	....	9.34	8.0	3.33	3.0
11.52	....	0.87	....	10.65	9.0	5.68	5.0
12.00	....	1.15	....	10.85	9.0	2.04	2.0
9.88	....	1.22	....	8.66	7.0	1.13	1.0
15.75	....	0.52	....	15.23	14.0	....	....
12.89	....	0.83	....	12.06	10.0	**1.70**	2.0
12.60	....	0.77	2.0	11.83	10.0	1.55	1.0
11.92	....	2.95	2.0	8.97	8.0	1.77	1.50
10.42	....	1.31	2.0	9.11	8.0	2.01	2.0
10.43	....	1.54	....	8.89	8.0	7.74	6.0
11.24	....	1.32	....	9.92	8.0	3.01	3.0
11.22	....	0.50	2.0	10.72	9.0	2.10	2.0
11.72	....	1.65	....	10.07	9.0	2.00	2.0
12.76	....	1.24	2.0	11.52	10.0	....	....

Results of analyses of commercial fertilizers

Laboratory number.	Manufacturer and Trade Name.	Nitrogen.	
		Found.	Guaranteed.
	OHIO FARMERS' FERTILIZER CO., COLUMBUS, O.:		
1410	Ammoniated Bone and Potash	0.76	0.85
1408	Corn, Oats and Wheat, Fish Guano	**0.86**	1.20
1497	Corn, Oats and Wheat, Fish Guano	**0.66**	1.20
1409	General Crop Fish Guano	**0.55**	0.85
	PHOENIX MANUFACTURING CO., ANN ARBOR, MICH.:		
1384	Huron Valley Brand	5.87	3.75
	RASIN-MONUMENTAL CO., BALTIMORE, MD.:		
1457	Rasin's Wheat and Truck Mixture	....	....
	SPEIDEL & SWARTZ, GRAND HAVEN, MICH.:		
1350	Celery Hustler	**6.67**	7.0
	STINGEL BROS., SAGINAW, MICH.:		
1522	*Stingel's	4.16	4.16
	SWIFT & CO., UNION STOCK YARDS, CHICAGO, ILL.:		
1476	*Swift's Bee Hive Fertilizer	**0.71**	0.82
1358	Swift's Complete Fertilizer	1.00	1.0
1440	Swift's Muriate of Potash	....	....
1441	Swift's Nitrate of Soda	15.62	15.65
1430	Swift's Onion, Potato and Tobacco	1.62	1.64
1477	*Swift's Pure Ammoniated Bone and Potash	**4.54**	4.75
1388	Swift's Pure Bone and Potash	**2.07**	2.50
1426	Swift's Pure Bone Meal	**2.06**	2.50
1431	Swift's Pure Special Bone Meal	2.25	0.82
1451	Swift's Special Park and Lawn Fertilizer	**5.34**	6.58
1360	Swift's Special Phosphate and Potash	....	....
1449	Swift's Strawberry Special	3.20	3.25
1478	*Swift's Sugar Beet Grower	2.47	2.50
1357	Swift's Superphosphate	1.66	1.64
1359	Swift's Truck Grower	0.91	0.82
1498	Swift's Truck Grower	0.97	0.82
1442	Swift's Vegetable Grower	**2.91**	3.29
	F. A. THOMPSON & CO., DETROIT, MICH.:		
1480	*Rose Nicotine Fertilizer	**1.58**	2.0
	THE TUSCARORA FERTILIZER CO., CHICAGO, ILL.:		
1481	*Acid Phosphate	....	....
1364	Ammoniated Phosphate	0.88	0.82
1402	Bone and Potash	....	....
1362	Michigan Special	**1.54**	1.65
1521	Michigan Special	1.59	1.65
1482	*Steamed Bone Meal	1.73	1.65
1483	*Tuscarora Bone Phosphate	....	....
1365	Tuscarora Fruit and Potato	1.90	1.65
1361	Tuscarora Garden	3.31	2.88
1363	Tuscarora Standard	**1.33**	1.65
1450	Tuscarora Trucker	4.46	4.11
1401	Wolverine Special	**0.69**	0.82
	THE WUICHET FERTILIZER CO., DAYTON, O.:		
1383	Onion and Truck Fertilizer	2.48	1.50

* Manufacturers' samples.

for 1907, expressed in parts in one hundred.

Phosphoric acid.						Potash.	
Total.		Insoluble.		Available.			
Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
10.32	....	2.19	....	8.13	8.0	3.86	4.0
11.20	....	2.74	....	8.46	8.0	2.04	2.0
10.46	....	1.96	....	8.50	8.0	2.36	2.0
9.35	....	1.32	....	8.03	7.0	1.45	1.0
16.23	18.0	6.75	....	9.48	8.0	....	....
13.31	....	1.26	1.0	12.05	10.0	**7.54**	8.0
3.97	3.75	....	....	....	....	1.33	1.25
18.55	18.55	5.01	5.01	13.54	13.54	....	....
8.52	9.0	0.42	....	8.10	8.0	3.16	3.0
10.37	11.0	0.77	....	9.60	8.0	1.10	1.0
....	....	....	....	....	....	59.83	50
....	....	....	....	....	....	....	....
12.39	11.0	3.22	....	9.17	8.0	**6.75**	7.0
16.80	16.0	....	....	....	....	3.51	3.0
25.48	23.50	....	....	....	....	3.67	3.0
27.92	25.0	....	....	....	....	....	....
26.57	27.50	15.30	....	**11.27**	12.25	....	....
12.21	8.0	5.73	....	**6.48**	7.0	....	....
12.14	11.0	1.15	....	10.99	10.0	2.10	2.0
12.55	12.0	2.72	....	9.83	9.0	**9.20**	10.0
10.90	11.0	1.12	....	9.78	8.0	6.05	5.0
10.88	12.0	1.31	....	9.57	8.0	2.12	2.0
11.41	10.0	1.25	....	10.16	8.0	**3.78**	4.0
10.15	10.0	0.55	....	9.60	8.0	4.05	4.0
12.50	10.0	1.93	....	10.57	9.0	10.51	10.0
0.72	....	....	....	....	....	7.44	6.0
17.12	....	0.26	2.0	16.86	14.0	....	....
10.63	....	0.99	2.0	9.64	7.0	1.28	1.0
12.27	....	0.50	2.0	11.77	10.0	2.70	2.0
9.98	....	0.44	2.0	9.54	8.0	5.15	5.0
10.25	....	0.72	2.0	9.53	8.0	**4.74**	5.0
29.07	20.0	....	....	....	....	....	....
10.95	....	0.22	2.0	10.73	10.0	....	....
11.58	....	1.12	2.0	10.46	8.0	11.13	10.0
13.59	....	1.31	2.0	12.28	8.0	4.93	4.0
11.34	....	1.25	2.0	10.09	8.0	1.94	2.0
12.54	....	3.57	2.0	8.97	8.0	7.92	7.0
10.28	....	0.65	2.0	9.63	8.0	4.03	4.0
12.83	10.0	1.73	....	11.10	8.0	**5.59**	8.0

After the manuscript of this bulletin had been sent to the printers, the following samples of the Buffalo Fertilizer Co.'s goods were drawn, at the request of the company, from a recent shipment:

Results of analyses of commercial fertilizers for

Laboratory number.	Manufacturer and Trade Name.	Nitrogen. Found.	Nitrogen. Guaranteed.
	THE BUFFALO FERTILIZER CO., BUFFALO, N. Y.:		
1531	General Crop	....	....
1542	General Crop	....	....
1532	Ohio and Michigan Special	0.88	0.82
1543	Ohio and Michigan Special	0.88	0.82

THE PROTECTION OF BUILDINGS FROM LIGHTNING.

A. R. SAWYER, PROF. OF PHYSICS AND ELECTRICAL ENGINEERING.

Bulletin No. 249.

All the modern ideas on protecting buildings from lightning are based on the reports of the Research Committee appointed in Great Britain a few years ago, which go to show that iron is preferred electrically to copper, as a lightning rod. One objection to iron being that it is liable to rust, therefore it is desirable to put the lightning rod up in one piece. Secondly, it should be well grounded and it should protect the highest part of the building. In regard to the first recommendation we find the following words:

"Now, however, it is perceived that it is not so much quantity of electricity that has to be attended to as electrical energy; that this electrical energy is stored between clouds and earth in dangerous amount, and that our object should be to dissipate it not as quickly but as quietly as possible. A sudden dissipation of energy is always violent. No one in his senses wishes to stop a fly wheel or a railway train suddenly; sudden or hasty dissipation is not what is wanted. Gun cotton possesses a store of potential energy locked up in it to a dangerous extent; if it be dissipated suddenly, as by percussion, a violent explosion results; but if it be dissipated gradually, as by a flame, the energy is got rid of without much damage, beyond the liability to fire. An armor plate may be able to stop a cannonball quickly, but a heap of sand or loose earth does it more safely, because more gradually.

So it is exactly with the store of energy beneath an electrified cloud or between one cloud and another. A lightning conductor of perfect conductivity, if struck, would deal with the energy in too rapid and sudden a manner, and the result would be equivalent to an explosion. A conductor of moderately high resistance, such as an iron wire, would get rid of it in a slower and therefore much safer and quieter manner, though with too thin a wire there may be risk of fire.

1907, expressed in parts in one hundred.

Phosphoric acid.						Potash.	
Total.		Insoluble.		Available.			
Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
13.00	11.0	3.63	2.0	9.37	9.0	2.42	3.0
13.17	11.0	2.51	2.0	10.66	9.0	2.37	3.0
11.48	12.0	1.72	1.0	9.76	11.0	1.38	1.0
11.85	12.0	1.27	1.0	10.58	11.0	1.22	1.0

The rush in any case, however, is likely to be rather violent, and, like an avalanche, it will not take the easiest path provided for it, as if it were a trickling stream, but will crash through obstacles and make its own path, some portions of it taking paths which would be quite unexpected. Hence, no one path can be said to protect others, and the only way to protect a building with absolute completeness is to inclose it wholly in metal. An invisible cage or framework of iron wires, however, descending vertically down its salient features, with the utilization of any metal in its construction, suffices for all practical purposes, unless the building is a powder magazine.

The effect of *points,* and of rain also, in gradually dissipating a charge, and thereby contributing to safety, has long been understood; but the feature which has not been known is that there are cases where points are wholly inoperative, viz, when the energy is stored between cloud and cloud, instead of between cloud and earth, and when the initial discharge takes place from one cloud to another; then the lower cloud is liable suddenly to overflow to earth through a region in which there was no previous preparation, and where any number of points, or a rain shower, or any other form of gentle leak, would have been quite inoperative. Then can a violent discharge occur to even the sharpest point; and a hot column of air, such as rises up a chimney, is even preferred to a conductor. These are the flashes against which points and rain are no protection, and these are probably those which do the most damage to protected buildings. But it must be understood that when a flash does occur through a building, it matters little which kind of a flash it is—both can be equally sudden and violent—but if the building is well provided with points, the first or prepared kind is not likely to occur, save in exceptional cases, the dangerous liability is then the sudden or overflow variety of flash.

These, then, are the two points of novelty:

1. The possible occurrence of a totally unprepared-for and sudden flash in previously unstrained air, by reason of overflow from a discharge initiated elsewhere, what is called the *B* spark, occurring as the secondary result of an *A* spark.

2. The effect of electrical inertia or momentum, so that the discharge is not a simple leak or flow in one direction, but a violent oscillation and splash or impulsive rush, much more like an explosion, and occurring in all directions at once, without much regard to the path which

had been provided for it; no more regard, in fact, than is required to enable the greater part of it to take the good conductors, and to prevent any part of it from being able to enter a perfectly inclosed metallic building.

Even a small lateral fraction of a flash is able, however, to ignite gas if there is a leak, or even to *make* a leak at a "compo"-pipe where it is crossed by a bell wire, and then ignite it; hence, after a building has been struck, careful watch should be kept for some time against the danger of fire.

The amount of protection to be allotted to any building is no doubt analogous to the question of insurance generally; that is to say, the amount of premium it is desired to pay may be compared with the capital at stake and the risk run; and this is doubtless a matter for individuals and public bodies to consider for themselves. What the committee can do is to make a study of cases of damage occurring to buildings which on the old lines were supposed to be protected, to tabulate them as below, and to ask for carefully recorded observations; they can also draw up such hints and suggestions as may be of use to architects whose clients desire their buildings to be protected in a more thorough but not necessarily a more expensive manner.

These objects, and these attempts at being useful, explain the existence of the present report."

Also the following rules were laid down by the Committee:

RULES FOR THE ERECTION OF LIGHTNING CONDUCTORS, AS ISSUED BY THE LIGHTNING ROD CONFERENCE IN 1882, WITH OBSERVATIONS THEREON BY THE LIGHNTING RESEARCH COMMITTEE, 1905.

[NOTE.—Paragraphs beginning with odd numbers refer to Lightning Rod Rules, 1882; those with even numbers to Lightning Research Committee's observations, 1905.]

1. POINTS.—The point of the upper terminal should not be sharp, not sharper than a cone of which the height is equal to the radius of its base. But a foot lower down a copper ring should be screwed and soldered on to the upper terminal, in which ring should be fixed three or four sharp copper points, each about six inches long. It is desirable that these points be so platinized, gilded, or nickel plated as to resist oxidation.

2. It is not necessary to incur the expense of platinizing, gilding, or electroplating. It is desirable to have three or more points beside the upper terminal, which can also be pointed; these points must not be attached by screwing alone, and the rod should be solid and not tubular.

3. UPPER TERMINALS.—The number of conductors or points to be specified will depend upon the size of the building, the material of which it is constructed, and the comparative height of the several parts. No general rule can be given for this, but the architect must be guided by the directions given. He must, however, bear in mind that even ordinary chimney stacks, when exposed, should be protected by short terminals connected to the nearest rod, inasmuch as accidents often occur owing to the good conducting power of the heated air and soot in the chimney.

4. This is dealt with below in suggestion 3 (page 24).

5. INSULATORS.—The rod is not to be kept from the building by glass or other insulators, but attached to it by metal fastenings.

6. This regulation stands.

7. FIXING.—Rods should preferentially be taken down the side of the building which is most exposed to rain. They should be held firmly, but the holdfast should not be driven in so tightly as to pinch the rod or prevent the contraction and expansion produced by changes of temperature.

8. In most cases it would be advantageous to support the rods by holdfasts (which should be of the same metal as the conductor) in such a manner as to avoid all sharp angles. The vertical rods should be carried a certain distance away from the wall to prevent dirt accumulating and also to do away with the necessity of their being run around projecting masonry or brickwork.

9. FACTORY CHIMNEYS.—These should have a copper band around the top, and stout, sharp copper points, each about one foot long, at intervals of two or three feet throughout the circumference, and the rod should be connected with all bands and metallic masses in or near the chimney. Oxidation of the points must be carefully guarded against.

10. As an alternative, the rods above the band might with advantage be curved into an arch provided with three or four points. It is preferable that there should be two lightning rods from the band carried down to earth in the manner previously described. Oxidation of the points does not matter.

11. ORNAMENTAL IRONWORK.—All vanes, finials, ridge ironwork, etc., should be connected with the conductor, and it is not absolutely necessary to use any other point than that afforded by such ornamental ironwork, provided the connection be perfect and the mass of ironwork considerable. As, however, there is a risk of derangement through repairs, it is safer to have an independent upper terminal.

12. Such ironwork should be connected as indicated below in suggestion 3. In the case of a long line of metal ridging a single main vertical rod is not sufficient, but each end of the ridging should be directly connected to earth by a rod. Where the ridge is nonmetallic a horizontal conductor (which need not be of a large sectional area) should be run at a short distance above the ridge and be similarly connected to earth.

13. MATERIAL FOR ROD.—Copper, weighing not less than 6 ounces per foot run, and the conductivity of which is not less than 90 per cent of that of pure copper, either in the form of tape or rope of stout wires—no individual wire being less than No. 12 B. W. G. Iron may be used, but should not weigh less than 2¼ pounds per foot run.

14. The dimensions given still hold good for main conductors. Subsidiary conductors for connecting metal ridging, etc., to earth may with advantage be of iron and of smaller gage, such as No. 4 S. W. G. galvanized iron. The conductivity of the copper used is absolutely unimportant, except that high conductivity increases the surges and side flashes, and, therefore, is positively objectionable. It is for that reason that iron is so much better.

15. JOINTS.—Although electricity of high tension will jump across bad joints, they diminish the efficacy of the conductor, therefore every

joint, besides being well cleaned, screwed, scarfed, or riveted, should be thoroughly soldered.

16. Joints should be held together mechanically as well as connected electrically, and should be protected from the action of the air, especially in cities.

17. PROTECTION.—Copper rods to the height of 10 feet above the ground should be protected from injury and theft by being inclosed in an iron pipe reaching some distance into the ground.

18. This regulation stands.

19. PAINTING.—Iron rods, whether galvanized or not, should be painted; copper ones may be painted or not according to architectural requirements.

20. This regulation stands.

21. CURVATURE.—The rod should not be bent abruptly round sharp corners. In no case should the length of the rod between two points be more than half as long again as the straight line joining them. Where a string course or other projecting stonework will admit of it, the rod may be carried straight through, instead of around the projection. In such a case the hole should be large enough to allow the conductor to pass freely, and to allow for expansion, etc.

22. The straighter the run the better. Although in some cases it may be necessary to take the rod through the projection, it is better to run outside, keeping it away from the structure by means of holdfasts, as described above.

23. EXTENSIVE MASSES OF METAL.—As far as practicable it is desired that the conductor be connected to extensive masses of metal, such as hot-water pipes, etc., both internal and external; but it should be kept away from all soft metal pipes, and from internal gas pipes of every kind. Church bells inside well-protected spires need not be connected.

24. It is advisable to connect church bells and turret clocks with the conductors.

25. EARTH CONNECTIONS.—It is essential that the lower extremity of the conductor be buried in permanently damp soil; hence proximity to rain-water pipes, and to drains, is desirable. It is a very good plan to make the conductor bifurcate close below the surface of the ground, and adopt two of the following methods for securing the escape of the lighting into the earth. A strip of copper tape may be led from the bottom of the rod to the nearest gas or water *main*—not merely to a lead pipe—and be soldered to it; or a tape may be soldered to a sheet of copper 3 feet by 3 feet and 1-16 inch thick, buried in permanently wet earth, and surrounded by cinders or coke; or many yards of the tape may be laid in a trench filled with coke, taking care that the surfaces of copper are, as in the previous cases, not less than 18 square feet. Where iron is used for the rod, a galvanized-iron plate of similar dimensions should be employed.

26. The use of cinders or coke appears to be questionable owing to the chemical or electrolytic effect on copper or iron. Charcoal or pulverized carbon (such as ends of arc-light rods) is better. A tubular earth consisting of a perforated steel spike driven tightly into moist ground and lengthened up to the surface, the conductor reaching to the bottom and being packed with granulated charcoal, gives as much effective area as a plate of larger surface, and can easily be kept moist by con-

necting it to the nearest rain-water pipe. The resistance of a tubular earth on this plan should be very low and practically constant.

27. INSPECTION.—Before giving his final certificate the architect should have the conductor satisfactorily examined and tested by a qualified person, as injury to it often occurs up to the latest period of the works from accidental causes, and often from carelessness of workmen.

28. Inspection may be considered under two heads:

A. The conductor itself.

B. The earth connection.

A. Joints in a series of conductors should be as few as possible. As a rule they should only be necessary where the vertical and horizontal conductors are connected, and the main conductors themselves should always be continuous and without artificial joints. Connections between the vertical and horizontal conductors should always be in places readily accessible for inspection. Visible continuity suffices for the remainder of the circuit. The electrical testing of the whole circuit is difficult and needless.

B. The electrical testing of the earth can in simple cases be readily effected. In complex cases, where conductors are very numerous, tests can be effected by the provision of test clamps of a suitable design.

29. COLLIERIES.—Undoubted evidence exists of the explosion of firedamp in collieries through sparks from atmospheric electricity being led into the mine by the wire ropes of the shaft and the iron rails of the galleries. Hence the head gear of all shafts should be protected by proper lightning conductors.

SUGGESTIONS OF THE COMMITTEE.

The investigations of the committee warrant them in putting forward the following practical suggestions:

1. Two main lightning rods, one on each side, should be provided, extending from the top of each tower, spire, or high chimney stack by the most direct course to earth.

2. Horizontal conductors should connect all the vertical rods (*a*) along the ridge, or any other suitable position on the roof; (*b*) at or near the ground.

3. The upper horizontal conductor should be fitted with aigrettes or points at intervals of 20 or 30 feet.

4. Short vertical rods should be erected along minor pinnacles and connected with the upper horizontal conductor.

5. All roof metals, such as finials, ridging, rain-water, and ventilating pipes, metal cowls, lead flashing, gutters, etc., should be connected to the horizontal conductors.

6. All large masses of metal in the building should be connected to earth either directly or by means of the lower horizontal conductor.

7. Where roofs are partially or wholly metal lined, they should be connected to earth by means of vertical rods at several points.

8. Gas pipes should be kept as far away as possible from the positions occupied by lightning conductors, and as an additional protection the service mains to the gas meter should be metallically connected with house services leading from the meter."

SYSTEM OF LIGHTNING PROTECTION USED ON COLLEGE BARNS.

BY L. J. SMITH, INSTRUCTOR IN FARM MECHANICS.

The planning of protection for the college barns was carried on with special attention to the needs of the average farmer along this line. The aim was for a cheap yet durable construction, simple enough for the farmer to make if he has the use of a forge, drill, and set of dies and taps. If these tools are not accessible, that part of the work in which they would be used can be done by any blacksmith.

Though the individual may buy his lightning rods from any of the several reliable firms who have such goods on the market, there is no reason why he should not install the rods himself, and the following pages may be of interest from that standpoint.

DISCUSSION OF MATERIALS USED.

CABLE.

A ½″, seven strand, double galvanized iron cable was used as the conductor. The only practical advantage of copper over the iron cable is in durability, the difference in conductivity being immaterial in lightning rod construction when the distance from the points to the "grounds" is relatively short. Indeed, it is maintained by some authorities that the higher resistance of the iron cable is of distinct advantage in that it prevents the charge from grounding so violently. When we think of the durability of common single galvanized fence wire, it is evident that a cable containing seven strands of larger wire double galvanized, will be serviceable for a long period of years. The difference in cost of iron and copper cable will more than offset their difference in durability. The above considerations led to the selection of iron cable for the conductor.

A ⅜″ seven strand double galvanized iron cable is undoubtedly of sufficient size for the average barn or house. The ½″ cable is quite stiff and heavy to handle and will take more time to put on the building. The ½″ cable costs about three cents a foot, the ⅜″ two cents. However, the essential thing is to have the cable heavily galvanized. Any hardware firm can get double galvanized cable sent them in a few days.

STAPLES.

The cable was fastened to the building *without* insulation by the means of 3″ staples placed from 24 to 30 inches apart. Two and one-half inch staples will do very well if they can be readily secured. Holes were drilled for the staples by the use of a gimlet bit and brace, as the staples split the shingles and ridge boards very easily.

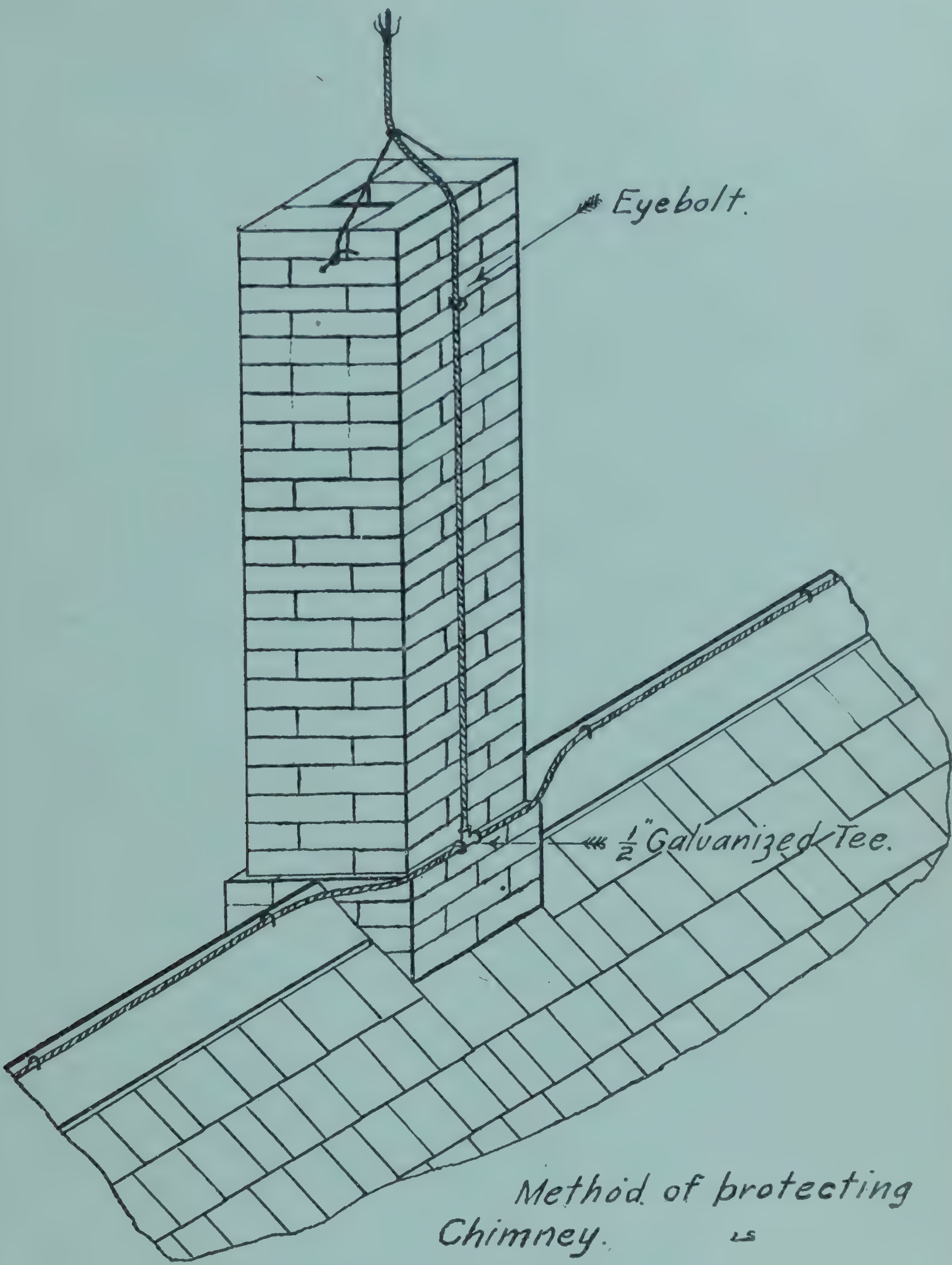


Fig. 1.

POINTS.

The points, with the exception of the ones used for chimney protection were made from ½″ round iron rods. They were 36 inches long when not on cupolas or extending along the side of the vertical 4x4 post which holds the rod supporting the end of the hay track. When

attached to the cupola or to the 4x4 post the points extend 30 inches above the same. The upper end is tapered about 3 inches to a point, this being done at the forge and finished with a coarse file. Threads were cut at the lower ends of the 36″ points, the other lengths being left unthreaded.

POINTS FOR PROTECTION OF CHIMNEYS.

It will be remembered that a heated column of air rising from a chimney affords an easier path for lightning than the cooler surrounding medium. Then, too, the chimney is generally the highest part of the building. Because of these facts, chimneys are struck more often than any other one part of a building. The chimney on the implement barn was protected in the following manner. The horizontal cable which runs along the ridge of the barn was passed around the chimney as indicated in Figure 1. On this cable was put a ⅜″ galvanized iron tee which was drilled and tapped in two of the ends at right angles with each other for ⅜″ set screws. A ⅜″ eyebolt, made by cutting off the head of a common bolt and turning an eye on the end, was put through the chimney four rows of brick from the top, and fastened on the inside with a nut and washer. A piece of the ½″ cable was used for the point, the upper end having four of the seven strands spread outward and upward, the remaining three strands being twisted together and standing vertically in the center of the four. After bending the point as shown in the drawing, the lower end was passed down through the eye bolt and into the tee, and was firmly secured by one of the ⅜″ set screws. The remaining set screw fastens the tee to the horizontal cable. A short piece of heavy galvanized wire is shown in the figure steadying the upper end of the point.

METHOD OF SUPPORTING POINTS.

The method used in putting up points is illustrated by No. 2 of Figure 2. The ½″ rod is screwed into a ½″ galvanized tee, (drilled and tapped at the proper angle), and fastened to the roof by means of a 10″ piece of ½″ gas pipe screwed into the tee. The gas pipe was prepared by first cutting threads on one end, then flattening the pipe on the anvil, first heating the pipe to a white heat in the forge. Then three ¼″ holes were drilled and countersunk for No. 10 wood screws. The flattened pipe is bent to fit the ridge board and first row of shingles. Care must be taken to drill and tap the tee at about the proper angle. The size drill used is 25-64 inch, but a ⅜″ or even a 13-32 drill will do very well. The threads cut on the half-inch rod should fit those tapped in the tee quite closely, and they should be just long enough to allow the rod to be screwed firmly against the cable when it passes through the tee. If the rod does not stand vertical after it is put up, it can easily be made so by bending the flattened pipe or by driving a staple close to the tee and on the side you wish the point tipped; and if this does not make the rod set vertical, it can be made so by pulling the upper end of the point in the direction you wish it to go, and striking the rod on that side close to the tee.

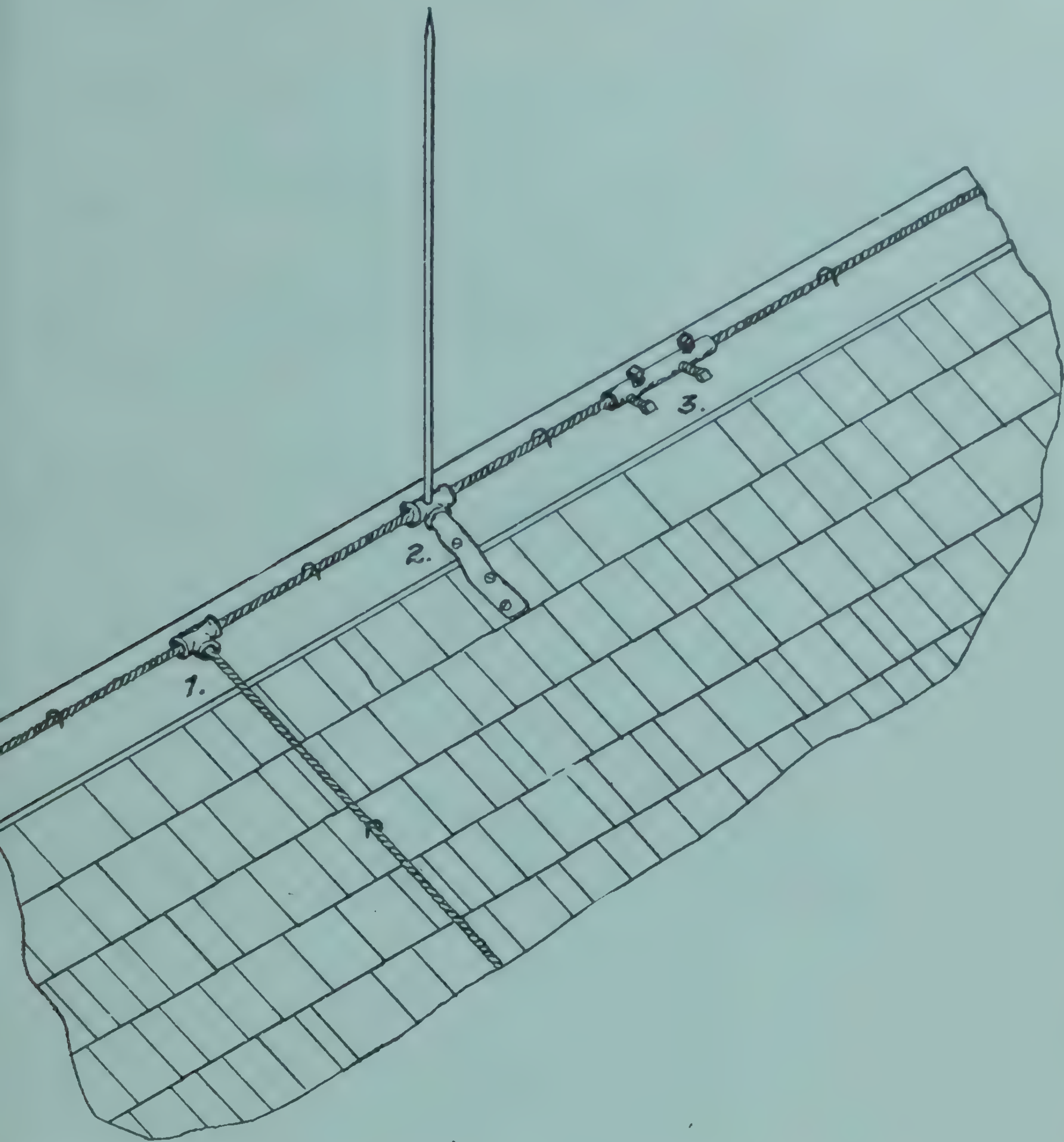


Fig. 2 Part of roof showing—

1. Connection of center ground" to horizontal cable.
2. Method of supporting point.
3. Method of connecting cables if a spice is necessary.

LS.

GROUNDS.

One of the most essential parts of a lightning rod system is the ecuring of a good connection between the conductor or cable and either lamp earth or water in the earth. The common term used is "grounding" the conductor. The ideal condition is reached when the "ground" xtends far enough beneath the surface of the earth to reach a permanent vater level. This condition is often attained in low localities or where stratum of clay is reached not far below the surface.

The lower end of the conductor or cable should extend at least to

permanently damp earth which is generally reached 8 or 10 feet below the surface.

Lightning meets with high resistance when discharged into dry ground. This fact is curiously illustrated when a heavy discharge strikes the sand dunes common to the shores of the great lakes. The tremendous resistance met by the lightning as it bores its way downward, fuses the sand into a vitrefied tube, which is sometimes called by the name Thunderbolt.

There is a stratum of clay under the college farm which is from 6 to 9 feet below the surface. Holes for the "grounds" were bored from one to two feet into the clay, depending upon the depth of the stratum, thus providing a good place for moisture to collect at the lower end of the "ground." The holes were bored by the use of an old 2″ wood auger welded to a long ½″ square iron rod. The auger was sunk into the earth by means of a handle 24 inches long made from a piece of 1″ square iron. A ½″ square hole was punched in the center of this handle through which the rod could slide. The handle could be fastened any place along the rod by means of a rough thumb screw made by flattening the head of a short ⅜″ machine bolt. When such an arrangement is not accessible, the hole for the "ground" can be easily made by driving a common 1 inch wrought-iron pipe into the earth and drawing it out again by means of a short chain and any piece of timber acting as a lever. The lower end of the pipe should be hammered to a chisel-like point. This will make it easy to drive the rod and to force aside any small stones. A crowbar is often useful in starting the upper part of the hole. In filling in about the cable, only fine sand was used, a pailful of water being first poured in about the cable to help the sand pack together. The best "ground" is secured when that part of the cable under the surface of the earth is in close contact with the soil throughout its whole length. With two exceptions, the barns protected from lightning have three "grounds" each; one going to ground at the center of the barn. The horse barn has two grounds, and the pure herd barn has four. It may be said here that one good "ground" is better than two poor ones.

The method of connecting the center "ground" to the horizontal cable running along the ridge board is illustrated by No. 1 Figure 2, where the cable coming up the roof from the center "ground" is fastened in the ½″ galvanized tee by a ⅜″ setscrew ¾ of an inch long, setscrews not shown in figure. The tee is drilled (5-16 inch drill) and tapped for two ⅜″ setscrews, one to hold the horizontal cable and one to fasten the cable running down the roof to the ground.

METHOD OF SPLICING CABLE.

If for any reason, the cable must be spliced, it can be quickly accomplished as shown in No. 3 of Figure 2, which simply represents a piece of ½″ galvanized iron pipe, 6 inches long, drilled and tapped for four ⅜″ setscrews, one set being drilled "on the quarter" with the other set. The ends of the cables are inserted in the pipe until they touch at the center and each end is then securely fastened by two setscrews.

PAINT.

All the parts of the system not galvanized were painted with aluminum paint. If at any time the barn is repainted, it would do no harm to paint the cables also.

GENERAL DESCRIPTION OF PUTTING UP THE LIGHTNING RODS—NUMBER AND LOCATION OF GROUNDS USED.

Figure 3 gives the relative size and location of the various barns, which have the following number of points and grounds.

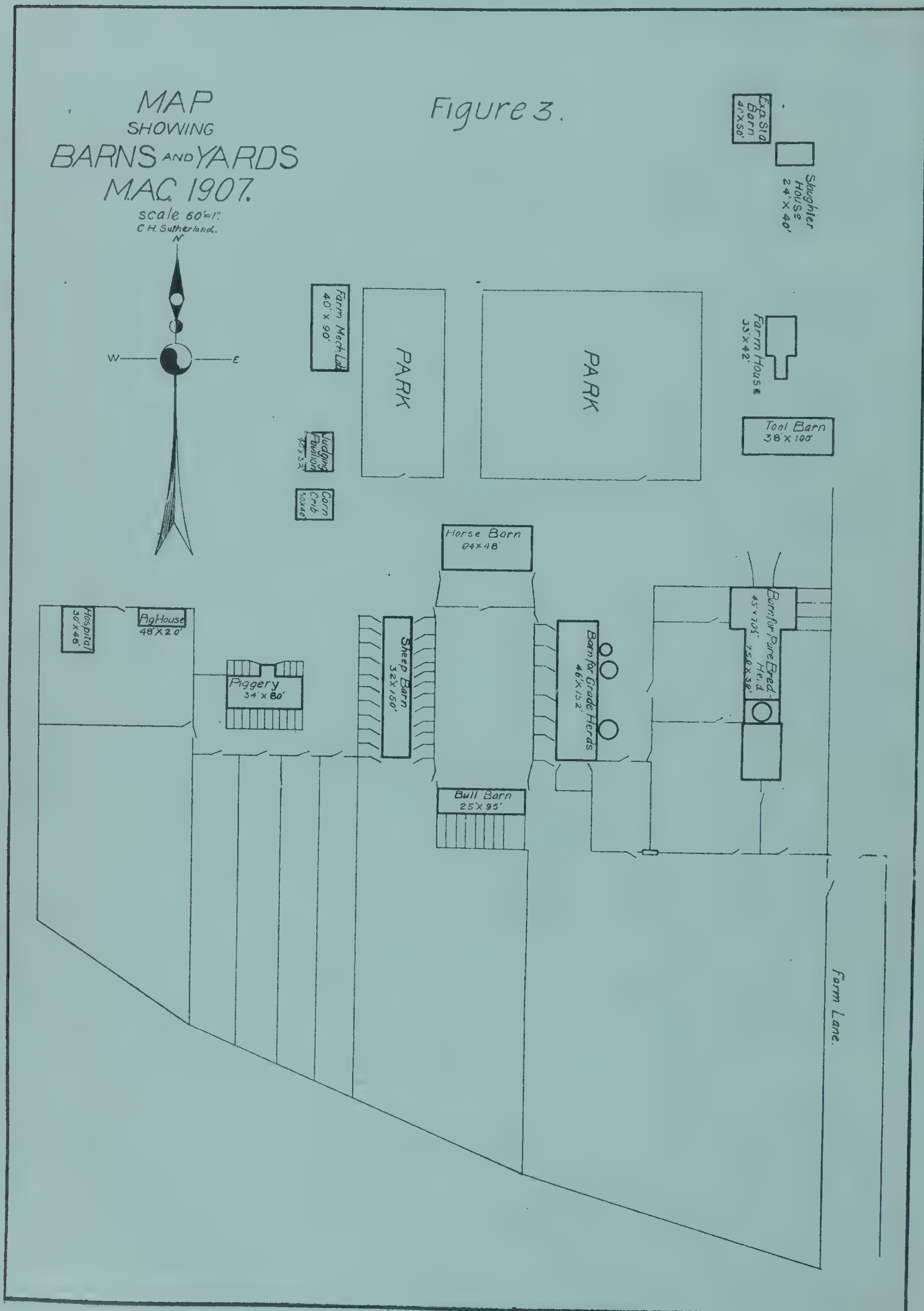
Barn.	Points.	Grounds.
Tool barn........................	6 (one on chimney)	3
Pure bred herds barn.............	8	4
Grade barn	5	3
Sheep barn	5	3
Bull barn	5	3
Horse barn	2	2

This aggregates 31 points and 18 grounds, less than two points for each ground. About 2,000 feet of cable was used on the six barns.

RODDING ON GRADE BARN.

Let us now consider one of the barns as an example and discuss the general method of putting up the rods. Figure 4 shows a west elevation of the grade barn. The silos are on the east side. On the west side are a series of small cattle yards. At the northeast corner is a door which is the most frequently used of any in the barn. The water drains off the roof on each side at about the center. Clearly we do not want our "grounds" any nearer than necessary to cattle that might be in the small yards adjacent to the west side of the barn, nor do we want a "ground" at the northeast corner because of the close proximity of the door. We do want a "ground" where the water from the eaves runs into the ground because the earth there will always be wet. If the water from the roof drained off any of the corners of the barn we would put one of our "grounds" there at once; but if manure will be regularly piled near one of those corners we would not put a "ground" at that corner as the liquid from the manure has a corrosive action on metals. These are some of the things considered in locating the "ground" connections. We finally decided on our "grounds" as shown in Figure 4.

The next question is as to the location of the points. The cupolas, being the highest points on the barn, should be protected as should the ends of the barn where the track is supported. We decide then on five points which should be as nearly equi-distant as possible. The cupolas are not an equal distance apart owing to the fact that the south end of the barn was an addition to the original. Therefore we planned to put points on the right ends of cupolas 1 and 2 and on the left end of cupola 3. (See Figure 4.)


MAP
SHOWING
BARNS AND YARDS
M.A.C. 1907.
scale 60'=1"
C.H. Sutherland.
N
W
E
Figure 3.
Exp. Sta. Barn 40'x50'
Slaughter House 24'x40'
Farm Mech. Lab. 40'x90'
PARK
PARK
Farm House 33'x42'
Tool Barn 38'x100'
Judging Pavilion
Corn Crib
Horse Barn 64x48'
Hospital 30'x48'
Ag House 48'x20'
Piggery 34'x80'
Sheep Barn 32'x150'
Barn for Grade Herds 46'x152'
Barn for Pure Bred Herd
Bull Barn 25'x95'
Farm Lane.

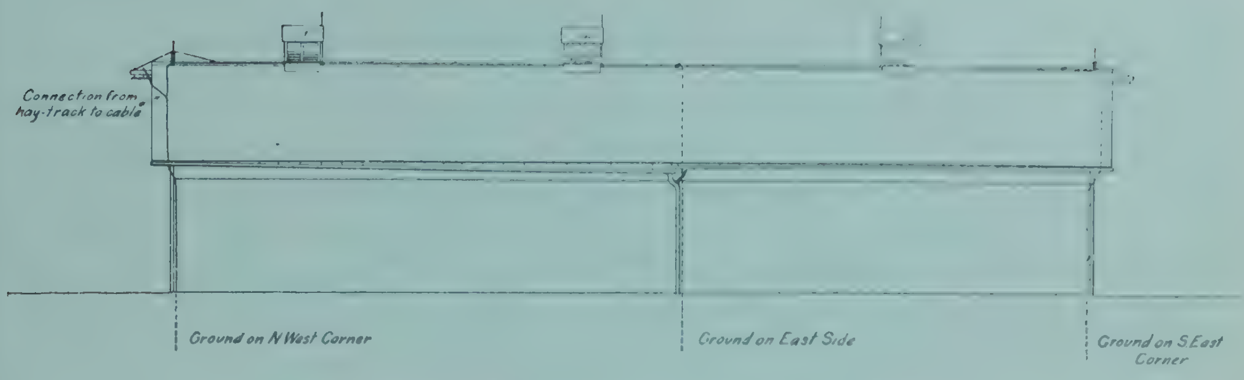


Fig 4. Outline Drawing of West Elevation of Grade Dairy and Beef Herds Barn.
Dimensions. length, 152' width, 46' rise to eaves, 22' length of roof, 30'
Height of cupola, 6'

Next we must figure on the material needed. The length of the main cable passing from the ground on one corner up to and along the ridge board and down into the ground on the opposite corner, is gotten from the following measurements:

Depth of "ground"	10 feet
Rise to eaves	22 feet
Distance up to the ridge of the roof	30 feet
Length of body of barn	152 feet
Distance down roof	30 feet
Drop to earth surface	22 feet
Depth of "ground"	10 feet
Total	276 feet

The length of the cable which grounds at the center of the barn is 62 feet. Two of the points will be 4 feet long, the remaining three will be $8\frac{1}{2}$ feet in length. None of the points need be threaded at the bottom as they all will be set into $\frac{1}{2}''$ tees, which are strung on the horizontal cable, and fastened in the same manner as the center ground cable is attached to the horizontal cable, (No. 1, Fig. 2.). The two end points will be fastened to the vertical 4x4 posts. The cupola points will be secured by boring a 9-16 inch hole through the end of the cupola roof and passing the point down through the hole into the tee where it is fastened securely with a $\frac{3}{8}''$ setscrew.

One inch holes are bored through the north and south sides of the cupolas in line with the ridge board so the horizontal cable can pass through the cupolas on a straight line and without a change of level. The cables going to the ground can be passed over the eaves-trough but it tends to bend the eaves-trough out of shape. The better way is to bore an inch hole near the end of the lower row of shingles and pass the cable down through this hole between them and the eaves-trough. The cable should be in contact with the trough.

After boring our holes for the grounds we are ready to put up the cable. It is pulled up to the ridge and passed through the cupolas, not forgetting to put the tees on the cable where they belong. One is most apt to forget the tee for the center ground cable. Having passed the cable over the roof, it is put down through the inch hole near the

eave-trough and into the hole bored for the "ground" at the corner of the barn. Beginning here, the cable is fastened with staples up along the corner board, on up the roof and along the ridge board down to the opposite corner where the other end is grounded. The cable for the center "ground" is then put up, and the points are fastened into the tees. The hay track is fastened to the cable (as shown in the figure) by a heavy galvanized wire. The earth is packed in about the "grounds" and the job is completed.

Let us now get at the cost of rodding the barn. The materials used and approximate cost of the same is as follows:

338 feet of ½ inch cable at..................	$0.03	$10.14
5 pounds 3 inch staples (27 in 1 pound) at....	.07	.35
3 12-foot lengths ½ inch round iron at........	.02	.72
6 ½-inch galvanized iron tees at..............	.05½	.33
12 ⅜ by ¾ inch setscrews at...................	.01	.12
1 ½-pint can aluminum paint at................		.35
Labor, 2 men 24 hours at......................	—	—
		$12.01

The amount of labor required to put up the rods depends materially on the care exercised in laying and fastening the cable. It takes considerable time to lay the cable straight and bore the holes for the staples; but the better appearance of the job and the boards and shingles saved from being cracked, makes it worth while. The use of the ⅜ inch cable will lessen the labor item considerably.

METHOD OF RODDING HORSE BARN.

Owing to the construction of the ridge board and cupolas of the horse barn (Fig. 5.) a somewhat different method was followed in rodding it. The ridge of the barn is covered with sheet iron extending down 10 or 12 inches on each side. The cupolas are made entirely of heavy galvanized iron and are in good contact with the metalic ridge board. The cable was put on the barn in the usual way, up one side, along on the iron ridge where staples held it in good contact, through the cupolas and down the opposite side with one point at each end of the barn. The iron cupolas, being in good contact with the cable need no points. They are in themselves sufficiently good conductors. The figure shows the cable at the right connecting the ground at the northwest corner of the barn.

GROUNDING OF FENCES.

The subject of lightning rod protection would be incomplete without mentioning the subject of the protection of the live stock in the fields from lightning striking the wire fences. Since the introduction of wire fences an increasing amount of stock have been killed in the fields. We learn from the weather bureau that in 1898 they collected reports which showed that in Iowa 73 per cent of the damaging strokes fell upon live stock. Animals to the value of $6,897 were killed in 153 strokes of lightning. The director of the Iowa weather and crop service, com-

menting on the loss of live stock by lightning in 1898, says in his Sept. 1898 monthly review:

"These reports show the interesting fact that of 266 head of live stock killed by lightning, 118 were found in close contact with wire fences; and also, that these fences were not provided with ground wires. That is to say, 44 per cent of the losses of stock may be caused by contact with wires charged with electricity.

"Unquestionably wire fences, as now constructed serve as death traps to live stock, causing a vast amount of loss every year. And it is also quite evident that a considerable percentage of damage may be avoided by the use of ground wires at frequent intervals, in the construction of wire fences. In some of the reports, it was stated that there were evidences that the lightning struck the fence at a considerable distance from the point where the stock was killed."

During 1898, Michigan lost live stock to the value of $1,695 by 34

FIG. 5.

lightning strokes. Her smaller loss compared with Iowa was doubtless due to the smaller number of wire fences used at that time in this more timbered state.

The grounding of fence wire is a very simple and inexpensive matter. All that is needed is to force a pointed rod down about 3 feet along the outside of every fifth or sixth post, and put down a piece of No. 9 or 10 galvanized wire, the wire being long enough to reach the top of the post. Then fasten this wire with staples so that it is in contact with all the horizontal fence wires. If the fence is being put in, such a wire may be stapled to the post before it is put on the ground. These ground wires should not be farther apart than 75 or 80 feet.

PROTECTION OF WINDMILLS.

Steel windmills on steel derricks need no protection as they are a protection in themselves; but a steel mill on a wooden derrick should be grounded with a heavy galvanized iron wire.

In closing, a word may well be said about watching the condition of the lightning system; like everything else, it may get out of repairs, and like everything else, the sooner repaired the better. One is apt to get the idea that a lightning system once put up will last indefinitely. It is as reasonable to apply such an idea to a windmill or pump as to the lightning rods.

COLLEGE FARM BUILDINGS.

BY R. S. SHAW AND J. A. JEFFERY.

INTRODUCTION.

Bulletin No. 250.

It is nearly fifty years since some of the first farm buildings were erected at the Michigan Agricultural College. At the time this work began the barn sites chosen were far remote from the nucleus around which the college buildings were being erected. But later developments produced an expansion which pushed campus and college buildings back into close proximity to the farm barns and yards. Figure 1 shows the grouping of the farm buildings in 1902. The beef cattle barn was only four rods from the agricultural building, and the horse barn still closer to the veterinary building. In addition to this the dairy, botanical, bacteriological, horticultural and library buildings were in close proximity to the main barns and largest open yard. These farm buildings had been erected years ago, and while the construction and fittings were doubtless the best of their time, they had become unsuitable for modern requirements. The advisability of tearing down the old and building entirely new structures was considered but abandoned, largely for the reason that the old buildings contained hardwood frames covered with white pine siding of a quality such as could scarcely be obtained on the market today at any price. The removal of these materials, in the tearing down process, would have destroyed them so as to render their further use impossible. As there was but one new building in the entire group, viz., the dairy barn, erected in 1900, it would have required the expenditure of many times the cost of moving and refitting the old buildings to replace them completely with new ones. In pursuance of the course adopted, therefore, a general plan for the building removal and re-equipment was devised and estimates made as to the cost of removal, refitting and addition of such new structures as were needed. These estimates called for the sum of $15,000; of this amount the Michigan State Legislature of 1905 appropriated by special enactment $10,000, the balance was furnished from the college building and improvement fund. In all this work no attempt whatever was made to erect mammoth, expensive or fancy structures, but rather to work solely on a utility basis, keeping within reach of feasible practices of the farmer in order that he might receive the greatest possible benefit therefrom. None of the old buildings were demolished, and all material of any value was used. Two new buildings were erected, a horse barn 48x94 feet and an extension 32x60 feet added to the sheep barn. This publication is offered, not for the purpose of furnishing models for the farmer, but rather with the thought that it may present or suggest ideas of practical value and at the same time serve as a safeguard against some known errors. The descriptions of the horse barn and silos have been prepared by J. A. Jeffery, the balance of the publication by R. S. Shaw.

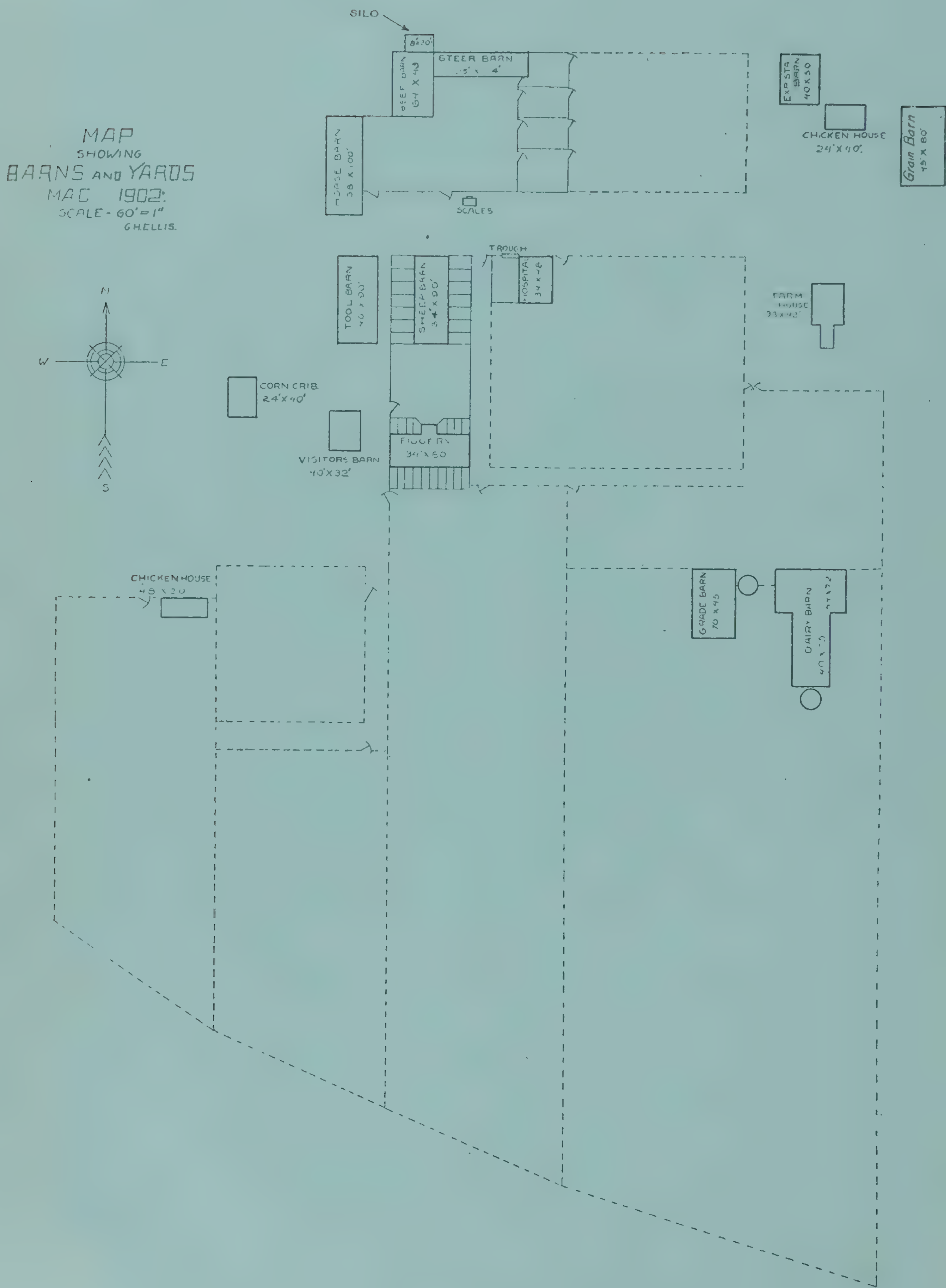

MAP
SHOWING
BARNS AND YARDS
MAC 1902.
SCALE - 60' = 1"
G.H.ELLIS.
N
W
E
S
SILO
STEER BARN
HORSE BARN
38 X 100'
SCALES
EXP. STA. BARN
40 X 50
CHICKEN HOUSE
24'X40'.
Grain Barn
TROUGH
HOSPITAL
TOOL BARN
SHEEP BARN
34'X90'
FARM HOUSE
CORN CRIB
24'X40'
PIGGERY
34'X60
VISITORS BARN
40'X32'
CHICKEN HOUSE
GRADE BARN
70 X 45
DAIRY BARN

Fig. 1.

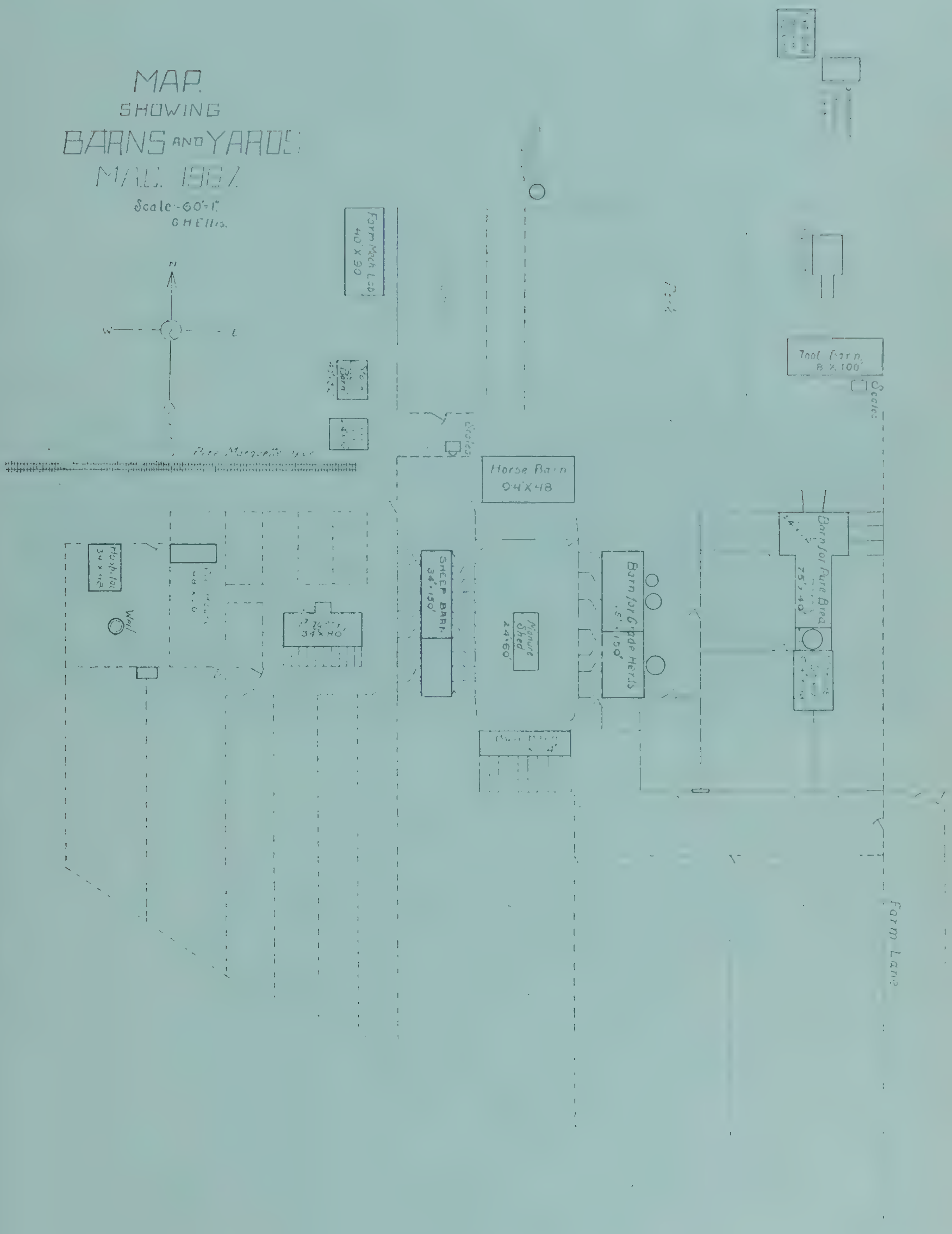

MAP
SHOWING
BARNS AND YARDS
Scale - 60' = 1"
Farm Mach Lab 40' x 90'
Horse Barn 94' x 48
SHEEP BARN 34' x 150'
Manure Shed 24' x 60'
Barn for Grade Herds
Barn for Pure Bred 75' x 40'
Tool Barn
Scales
Well
Farm Lane

Fig. 2.

LOCATION AND GROUPING OF FARM BUILDINGS, YARDS, ETC.

In a state like Michigan, which was settled at an early date, the question of the selection of the site for buildings in its relation to the whole farm and its general operations is one that is now quite largely decided. These sites, whether on one corner of the quarter or half section, or in the centre, have already been chosen, and barns, houses and roadways located, in many instances beyond the possibility of change. This question is an important economic factor which should receive the most careful consideration of those equipping new farms with buildings.

Fig. 3.

In adding additional buildings to the group already established, or in moving and remodeling old ones the exact location of the building is in many ways an important factor. A good building site must be high and well drained with sufficient slope in every direction from the buildings. Should the country be almost level, as is sometimes the case, then the buildings should be set well up on their foundations, so that earth can be graded in against the walls, thereby furnishing dry, firm yards and walks. We recall one instance in which an ideal building site was chosen, but the barn was placed down in an excavation so low that some thousands of yards of earth had to be removed in order to secure a slope away from the barn instead of toward it. It does not seem rational to suppose that such conditions could exist, but careful observation throughout a long period shows that many barnyards are veritable mire holes; in many cases, with the deepest and softest spot directly in front of the stable door. We recall one instance in which a group of barns, forming three sides of a court, was placed on such a low site that the yards had to be paved with hardheads to render them passable for both animals and attendants, and all this, too, within a few rods of an ideal location.

Despite the fact that only very ordinary judgment would seem to decree otherwise, the truth still remains that the greatest mistake in building operations is that of not getting the foundations high enough. It is appalling the number of farm buildings resting on, or even in the ground, with sills and lower ends of the siding completely rotted away. There are thousands of old barns in the state which, if raised and furnished with foundations, could be refitted and made useful, at very little expense, for years to come. Most of these old buildings possess good frames and siding. Since cement has come into such general use the farmer can easily construct grout foundations without any outlay whatever for professional labor, owing to the ease with which the work can be accomplished.

In grouping farm buildings on a particular site, or in placing them in relation to one another from an economic standpoint, two common practices seem to prevail. Buildings are either grouped to form an unbroken line or square, or they are placed promiscuously without any definite relation one to another. It is a common practice in some parts of the country, particularly New England, to have house, woodshed, carriage building, horse stable and other farm buildings joined in a continuous string, so that the most remote one can be reached from the house without going out of doors. Barns are frequently placed so as to form a court, three sides of a court, or an L; this is usually done to secure a yard protected from wind and have easy access to the stores of fodder in the barn and to the stack of straw in the yard. Undoubtedly the most satisfactory grouping of farm buildings, except for danger of loss by fire, is secured by placing them in the form of a square surrounding a court. The chances of complete loss by fire are such, however, that this plan should receive very careful consideration before adoption. No matter how perfect the water system to guard against fire may seem to be, it is a general rule that if a barn takes fire from lightning or other causes, it is almost certain to be completely destroyed because of the very combustible material of which it is constructed, and the hay, straw and dust found therein. If barns are grouped to form a square, adequate gaps should be left at the corners of the square for fire protection; then the group is only measurably safe even with a good water system.

Figure 1 shows the arrangement of the M. A. C. farm buildings prior to the removal and regrouping, and serves as an apt illustration of the promiscuous placing of buildings. There are many disadvantages in this system, some of which are: (1) The distance which herdsmen, shepherds and various attendants are required to travel in performing the day's work is too great. Under the present grouping shown in Fig. 2, in making a round trip from the farm house through horse, cattle, sheep and swine barns, an attendant must travel about 2,100 feet in order to see the 23 horses, 225 cattle, 200 sheep and 150 hogs. Under the old grouping he had to travel about 2,400 feet in making the round trip of the buildings which housed but half this amount of live stock. Much time and energy is wasted where herdsmen and attendants have to travel frequently from building to building in performing their labor. (2) It is also desirable in grouping buildings to centralize the position of the manure yard or shed, thus reducing to a minimum the number of manure piles. (3) The food supplies should not be too widely scattered. (4) Proper grouping of buildings also greatly facilitates matters in providing

foundation and eave trough drains. In this particular instance the grouping of the buildings has added greatly to the ease with which the live stock can be inspected by the public. Owing to the fire protection offered by three hydrants, attached to six-inch mains, not more than 75 feet of open space was left between the buildings at the corners of the court. With less efficient water systems much wider gaps should be provided. The yard can be protected from wind by high board fences joining the buildings.

The building designated as the hospital, shown in Fig. 1, was erected for an experimental cattle feeding barn and later used for sick animals. Its use for this purpose, in such a location, was exceedingly unfortunate, being in the center of the group of buildings containing the breeding stocks and in close proximity to thorofares along which animals were required to pass in going to and coming from the pastures. The location given this building, according to Fig. 2, places it in a remote corner, on the west of the building group between the river and the railroad spur, so that diseased animals, shipped in, could be unloaded directly in front of the hospital door without passing by or through the other yards. While the hospital building adjoins the pig yards, only horses, cattle and sheep are admitted to it; swine diseases are handled in the bacteriological hospital.

Yardage.—According to the original arrangement there were less than a dozen yards or paddocks for the use of all classes of live stock. In the new over two dozen have been provided. These are very necessary owing to the large number of breeds kept. In addition to these paddocks or larger yards, there are a large number of small ones adjoining the pens. Of course, such a large number of lots, or paddocks, is not needed about the ordinary farmer's group of buildings where but one breed each of cattle, sheep and hogs are kept. In general, however, too few paddocks are provided near the farm buildings.

Construction of Paddock Fences.—During the past half dozen years a great many of the strongest woven wire and metal fences of various sorts have been used to separate the barnyard lots. We have found the best and strongest of these to be very short lived when used to enclose small lots containing horned cattle, particularly if there are cattle on both sides of the fence, the tendency being to fight through the fence, breaking and slipping the wires. While these fences answer admirably for the larger lot or pasture field, we have discarded them for the paddock. The style of fence used consists of two by six-inch hemlock spiked to cedar posts, placed eight feet apart. The material is spaced six inches apart, and the bottom being six inches above ground, the top of the fence is five feet high. The posts were tarred and notched one inch on the side to receive the two by sixes. This is an expensive fence, but is durable and strong; about one-half mile has been constructed for yardage. No chances could be taken with yard fences because of the close proximity of the experiment station plots and horticultural grounds. The various kinds of gates in use are being replaced by wooden structures four feet high, consisting of five 1x4-inch pine strips, with a 1x6 piece at the bottom.

Yard Paving.—When the yards were brought to the proper grade to prevent water from standing anywhere, and, in fact, to cause it to run off quickly, the work of paving began. In this case we use cinders secured

from our own power plant. They are put on in layers about six inches thick and crushed down with a road roller. This makes the best form of yard paving or walk that we have used. Of course, farmers in general cannot secure this material, but there are many in the vicinity of towns or cities who can. The steam road roller is of course not available, except to the few, which prevents the completion of the pavement at once, but in time the stock will trample cinders down hard and firm. The cinder paved yard becomes so firm and smooth that they can be scraped easily and cleaned frequently, thus effecting a material saving in fertilizer.

Fig. 4.

THE NEW HORSE BARN.

An examination of Fig. 5 shows the frame of our new horse barn to be of Shawver type, somewhat modified. The frame is 94 feet long and 48 feet wide, with 18 foot posts. Fig. 5 gives a fair idea of the general construction of the frame, and Fig. 7 shows the detail of the construction of the bent. There are two stories. The lower story, 9 feet 6 inches in the clear, is occupied by 18 single common stalls, 5 box stalls, a carriage room 20x28 feet, feed room, watering troughs. The upper story is for mow and granary purposes.

The foundation is of cement with walls 14 inches at the top, widening inward toward the bottom.

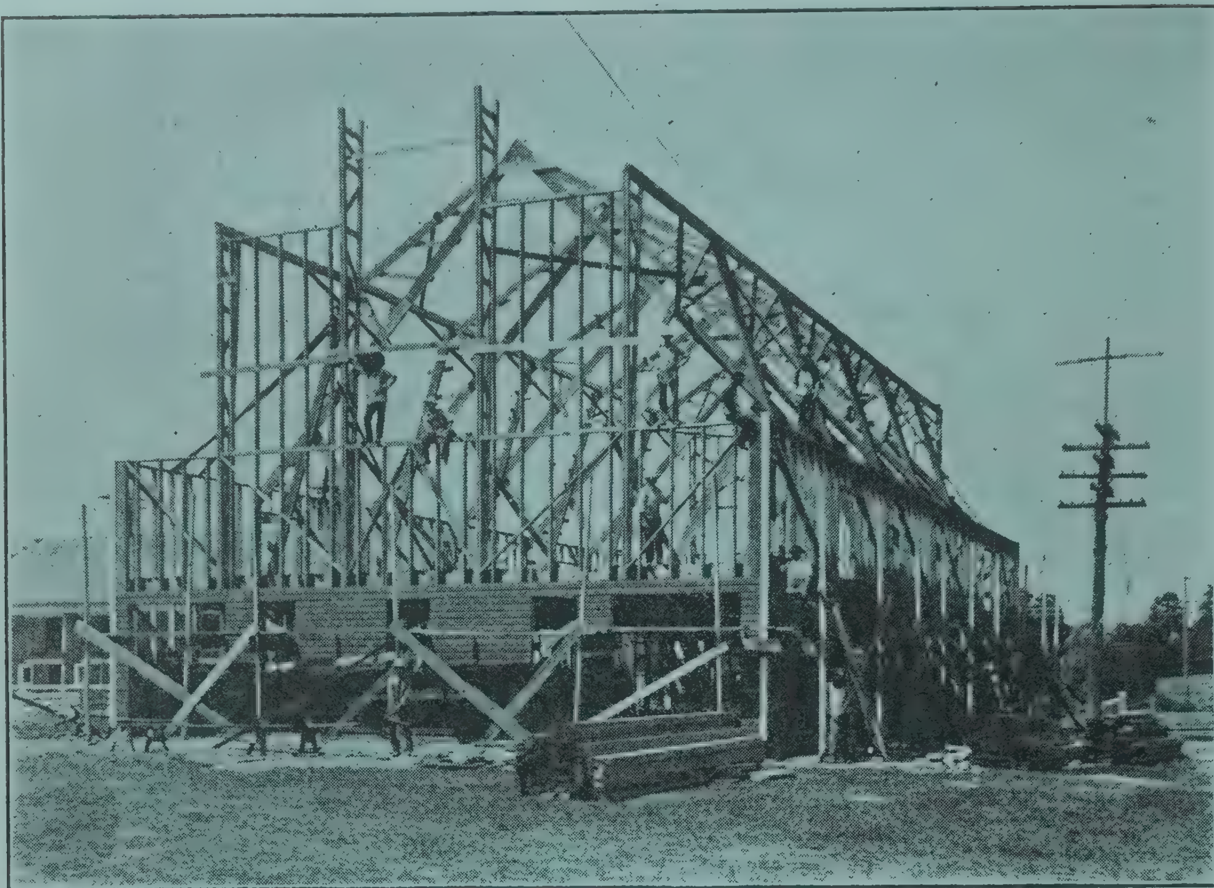


Fig. 5.

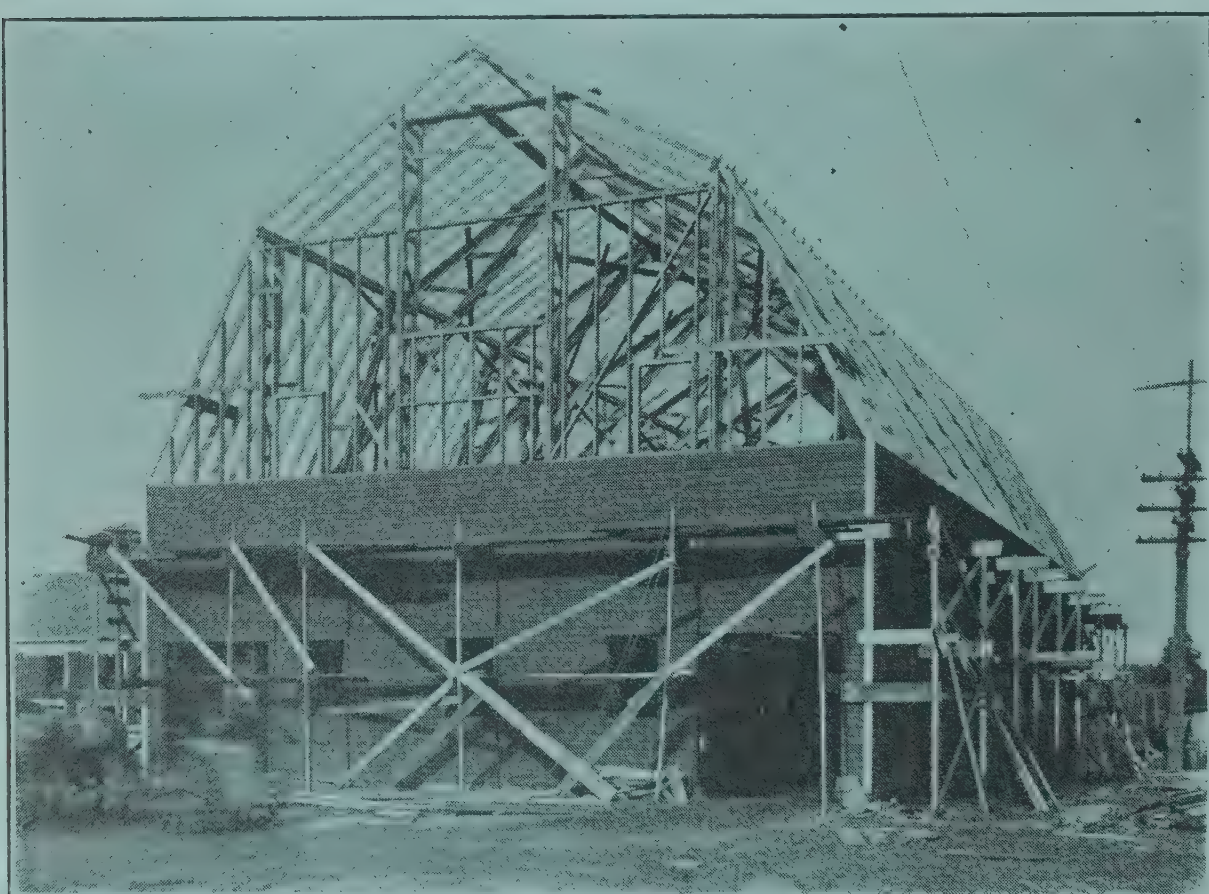


Fig. 6. New horse barn partly sided and with rafters in place.

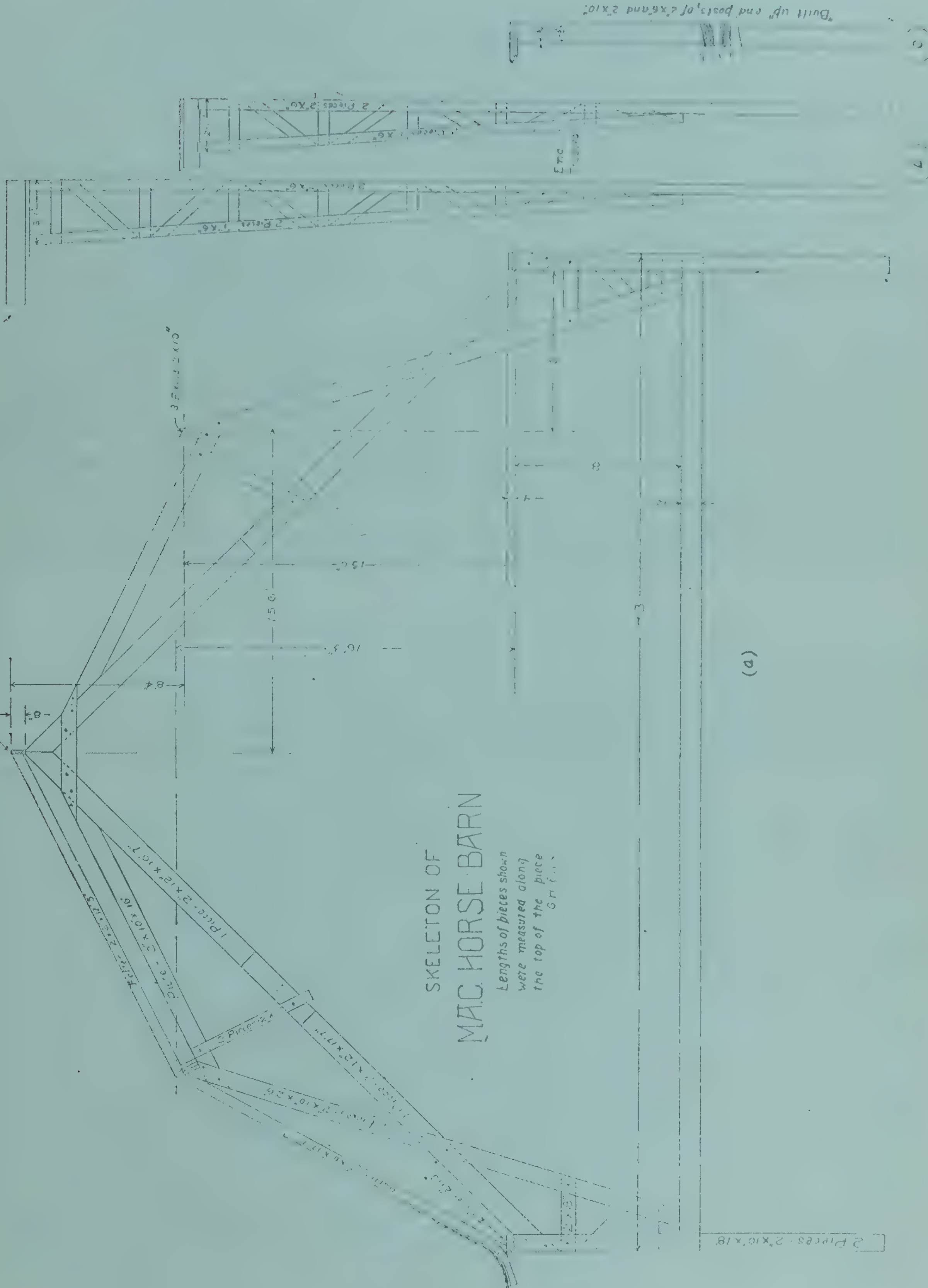

SKELETON OF
M.A.C. HORSE BARN
Lengths of pieces shown were measured along the top of the piece

Fig. 7.

The bents, plates, purline plate, ridge pole, beams and end trusses and most of the posts are of southern pine. The rest of the timber of the frame is hemlock and white pine, the latter used only for making splices.

The sills are made up of a 2x10 spiked upon a 2x12, the 2x12 being bolted at intervals to the foundation by bolts set in the foundation walls.

The five bents are placed 16 feet apart, center to center. The center of the first bent is 16 feet from the east end of the frame, while the center of the fifth bent is 14 feet from the west end of the frame.

The studs are 2x6 by 18 feet, placed 2 feet apart, center to center. The corner posts are built of two 2x10's and two 2x6's, hemlock, making hollow posts 6x14 inches, 18 feet long. See Fig. 7. The plates are made up of two pieces, 2x10, the lower piece spiked to the studs and bents, the upper piece spiked to the lower piece.

The purline plates consist of two 2x10's, held apart and reinforced by a 2x10, 8 feet long, placed over each purline post.

The ridge-pole is 2x8 inches.

The rafters are 2x6 inches, placed two feet apart, center to center, and are braced by nailing pieces 2x6x18 feet to the lower side as shown in Figs. 8 and 9. The lower edges of the rafters are set in 4½ inches from the outer edge of plate and lookouts are provided to carry the cornice. See Fig. 7.

The construction of the ends will be best understood by studying Fig. 5.

The end walls are strengthened by truss posts, the construction of which is shown in Figs. 5 and 7. There are three of these at the west end, one under each purline plate and one under the ridge-pole. At the east end there are four of these truss posts, one under each purline, and one on each side of the large door under the peak.

Each joist (of the upper floor) consists of three pieces 2x12 by 16 feet, spliced end to end, thus forming a joist 48 feet long and reaching the width of the frame. These splices are made by placing two 2x12's end to end and thoroughly nailing with tenpenny board nails, on each side of each joint, a piece of 1x12, 6 feet long. The joists so constructed are set two feet apart. The ends of each joist are well nailed to opposite studs and are further supported at the ends by 1x4 strips ribboned into the studs so that the lower edges of the joists stand just 9 feet above the sills. In ordinary construction the joists would be set 18 inches apart.

The joists are supported between ends by beams built up of four 2x12's, southern pine. Four of these beams extend through 62 feet of the length of the barn, while for the remainder of the length only three beams are used. At the east end of the barn an exception is made to this general distribution of joists. Here where a granary is supported, for a small area the joist are placed one foot apart.

The frame is well braced, and the manner of bracing is shown in Figs. 5, 6 and 8.

The barn is sided with ⅞ inch German siding of southern pine of good quality.

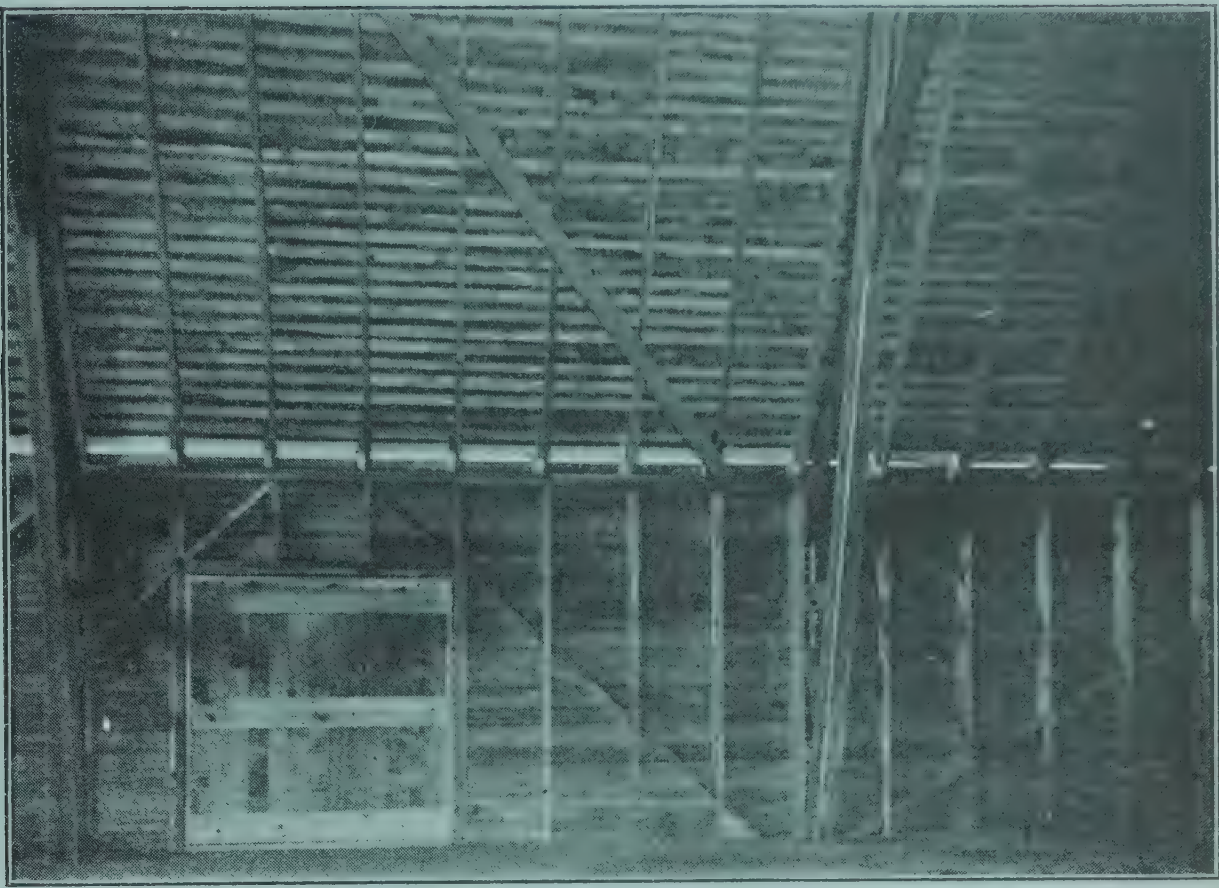


Fig. 8.

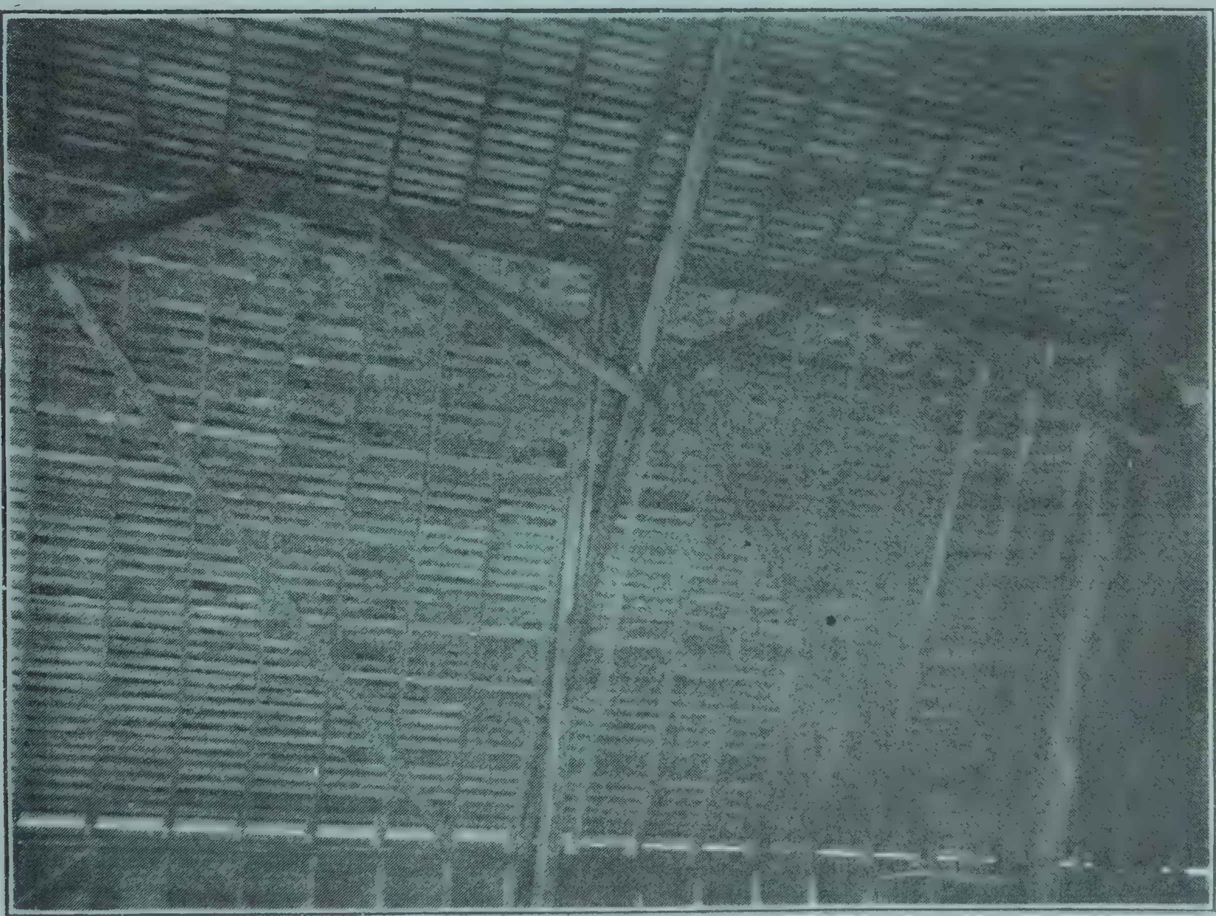


Fig. 9.

For the roof $\frac{7}{8}$x$3\frac{1}{2}$ in. roof lath placed $4\frac{1}{2}$ inches, center to center, is used instead of ordinary sheathing. It is believed, and the belief seems to be well borne out in our dairy barn, that the roof lath insures a drier and therefore more durable roof than does the ordinary sheathing.

The cornice is of the "railroad" or open type, and is supported by lookouts which project 21 inches from the plates and end rafter respectively. The lookouts for the ends are made of dressed 2x4's placed about three feet apart in the usual way. The lookouts for the sides are sawed from dressed 2x6 timber and are nailed one to each rafter. See Fig. 4 and Fig. 10. (Page 58.)

The fascia—that part of the cornice nailed to the ends of the lookouts or rafters and over which the shingles project—is of 1x6 whitewood.

The plancher is of $\frac{7}{8}$ inch double-beaded ceiling laid lengthwise of the cornice. The plancher is that part of the cornice nailed to the lower edge of the rafter or lookout in the box cornice, and to the upper edge of the rafter or lookout in the railroad or open type.

The shingles are best grade cedar. Before laying, the shingles were dipped one-half to two-thirds their length in a good quality of dark brown paint and allowed to dry. They are laid $4\frac{1}{2}$ inches to the weather.

The cupolas are of galvanized iron, and are $4\frac{1}{2}$ feet x$3\frac{1}{2}$ feet x6 feet high, 10 feet high to top of roof.

The windows are two sash windows, six lights (10x12) to the sash, and requiring frames 35x54 inches, inside measure. Fig. 11 shows the general distribution of these windows. Those on the sides behind the horses are placed about ten feet apart, center to center. This arrangement provides an abundance of light for the horses.

The lower doorways, the width and distribution of which are shown in the ground plan (Fig. 11) are all 9 feet high. The doors except the small one at the southwest are single, are made of a single thickness of southern pine, and are hung upon tubular tracks. The other door is double thickness of southern pine and is hung with hinges. The large door* under the peak, see Figs. 4 and 12, is 10x14 feet, and is suspended upon pulleys by steels cords with weights. The threshhold of the door frame is hinged. If the door be raised a few inches, the threshhold may be turned up, when the door may be lowered out of sight and the threshhold turned back into place.

The side doors, of which there are two on each side, opening into the mow, are 6x6 feet, and are built and hung in the same manner as the lower doors.

Fig. 11 shows the general plan of the lower floor.

The walls are ceiled with southern pine flooring.

The ceiling is ceiled with $\frac{3}{4}$ double-beaded southern pine ceiling, with 2 inch bed-mold in angles of ceiling with walls. The beams are cased with southern pine, with 2 inch bed mold at angles of beam with ceiling.

The carriage room, 28x28 feet, is set off from the rest of the floor by a partition of 2x4 inch hemlock, ceiled on both sides with flooring.

The walls of the small feed room at the east end are constructed in the same manner as those of the carriage room.

*This door is copied after that on the horse barn of Hon. A. P. Bliss, of Saginaw, Michigan.

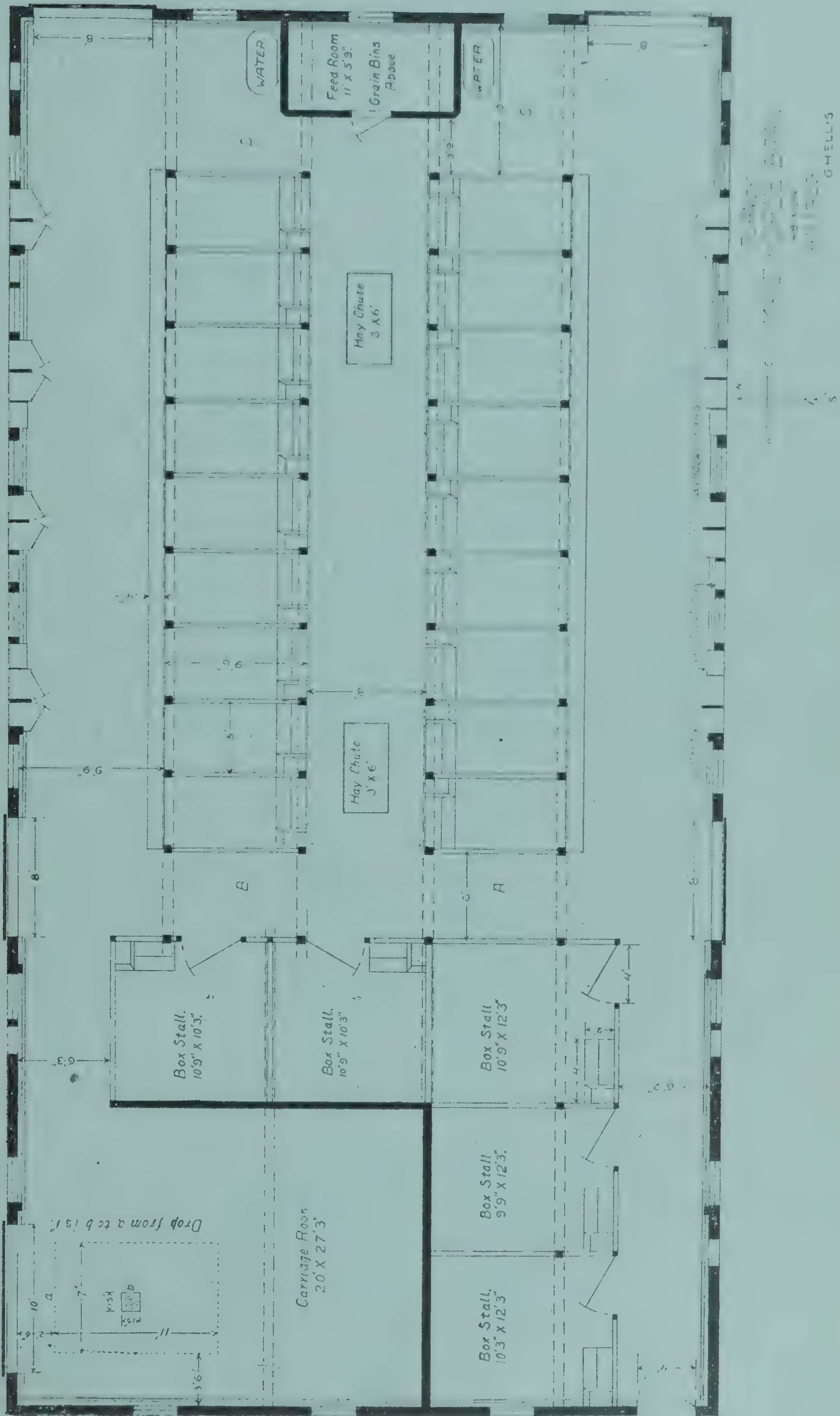

WATER
Feed Room
11' X 5'9"
Grain Bins
Above
WATER
Hay Chute
3' X 6'
Hay Chute
3' X 6'
B
A
Box Stall
10'9" X 10'3"
Box Stall
10'9" X 10'3"
Box Stall
10'9" X 12'3"
Box Stall
9'9" X 12'3"
Box Stall
10'3" X 12'3"
Carriage Room
20' X 27'3"
Drop from a to b is 1'

Fig. 11.

The floor of the lower story is of cement, set, in general, 4 inches below the top of the foundation wall. In each of the box stalls the floor drops ½ inch from the edges to the center. Fig. 11 shows the floor arrangement in the carriage room for washing vehicles. In this there is a drop of 1 inch for the purpose of carrying water, used in washing, to the sewer.

Fig. 13 shows the modification in the cement floor for the horse stalls.

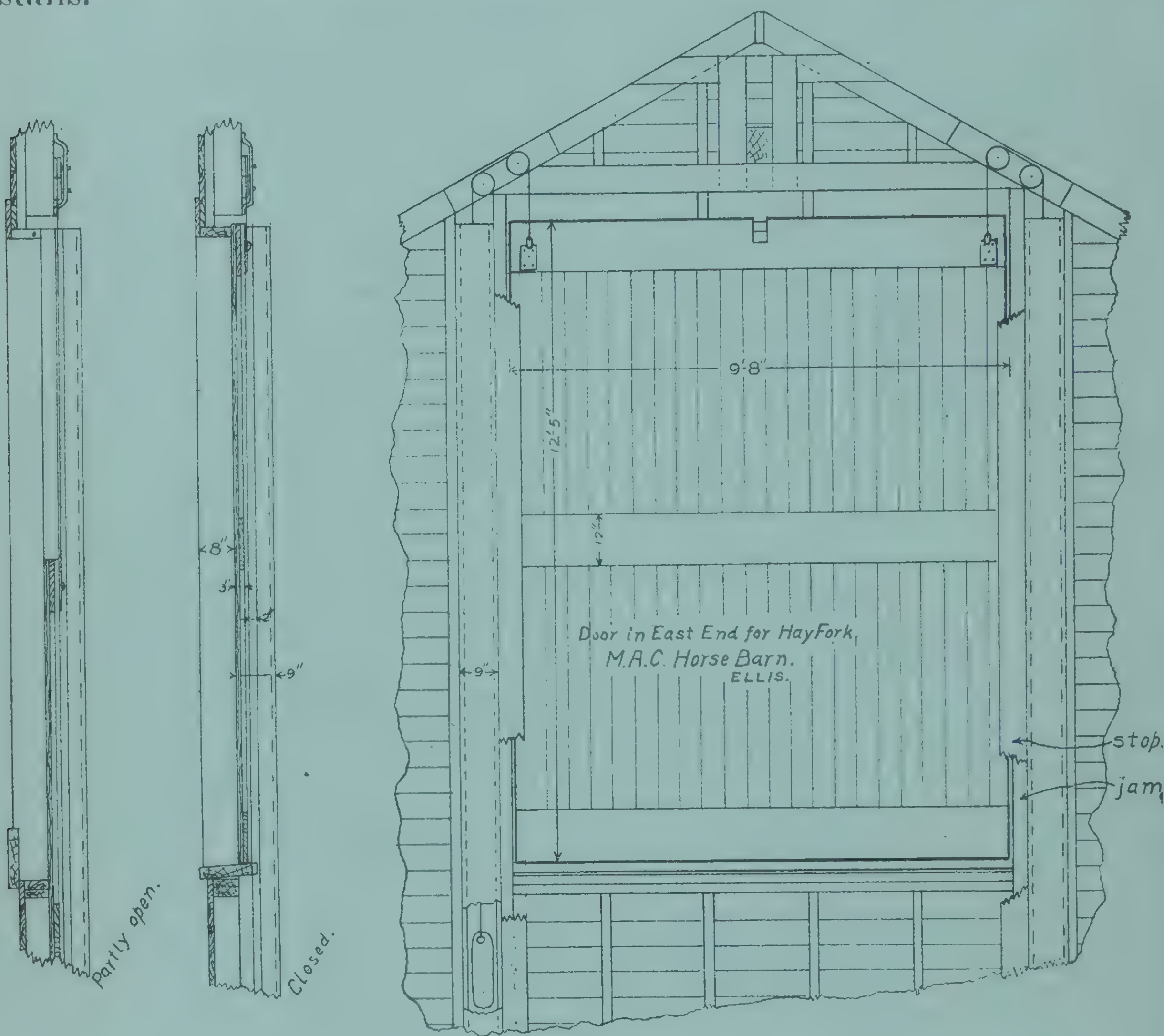


Fig. 12.

The manner of building the floor may be of interest. That portion occupied by the carriage room and box stalls is built in the ordinary way: i. e., in sections, using forms built of 2x4's. The tops of these forms determine or establish the surface of the floor and must, therefore, be carefully set. The lower or coarse layer is of coarse gravelly sand, and cement in the proportions of seven to one. The finishing layer is of screened sand and cement in the proportions of two to one.

In putting in the rest of the floor, the piers carrying the rear post and partitions of the stalls (marked 2 in Fig. 14) were first laid. To accomplish this a plank form was used. This form was made sufficiently deep to mold the pier to slightly below the bottom of the gutter in the the rear and to slightly below the floor on the sides and front end.

When the form was properly placed, which was so that the top of the finished pier should stand level and 5 inches above the general level of the floor, or one inch above the top of the foundation walls, it was carefully filled with a rather over wet mortar of sifted sand and cement in the proportions of 5 to 1. In this operation the mortar spread out somewhat beyond the lower edge of the form over the ground.

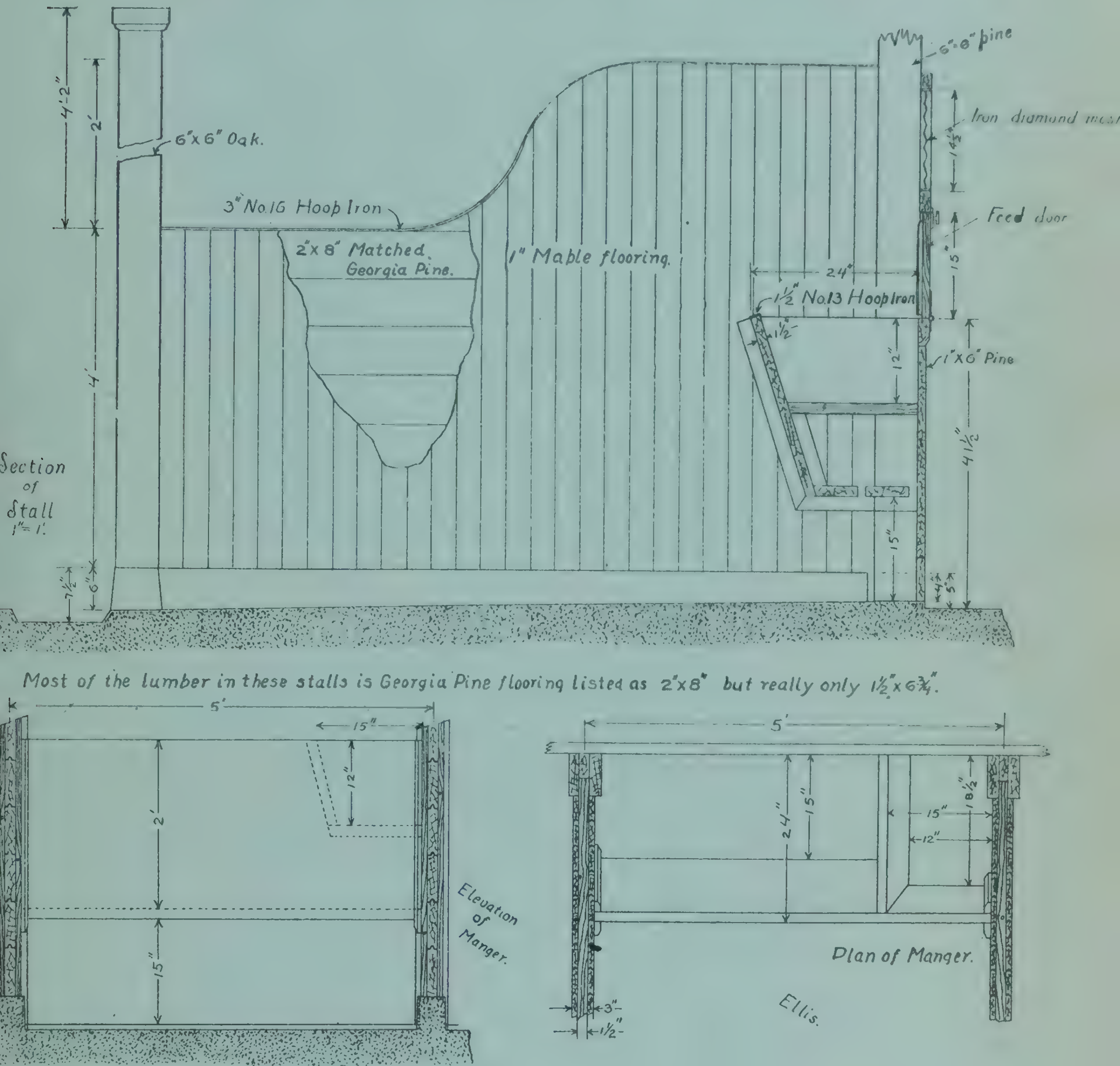


Fig. 13.

In filling the form great care had to be exercised to remove the bubbles of air which were inclined to lodge in the mortar against the walls of the form and thus to leave holes of various sizes in the surface of the piers. To remove these bubbles the masons carefully worked a trowel or other thin steel tool back and forth in the wet mortar against the walls of the form.

In a few hours after filling (depending on the temperature) the mortar sets sufficiently to remove the form, to be set for another pier.

While the piers (2 in Fig. 14) were being built and given time to properly ripen (or set), the section between the box stalls and the

common stalls, was built, then the feed alley floor (3 in Fig. 14), then the sections between the gutter and foundation walls (4 in Fig. 14), then the floor east of the stalls (C and D in Fig. 11).

It will be noticed that the floor falls 1 inch from the wall to the edge of the gutter.

When the piers and feed alley floor were sufficiently set, the stall floors (5 in Fig. 14) were laid. These floors stand 1 inch above the feed alley floor at that end and fall 2 inches to the inner edge of the gutter. To get this slope (or fall), two gages of proper fall were placed upon the adjacent piers; then with templates of proper size to work upon the gages, the grout and surface dressing were stricken off to give the proper fall.

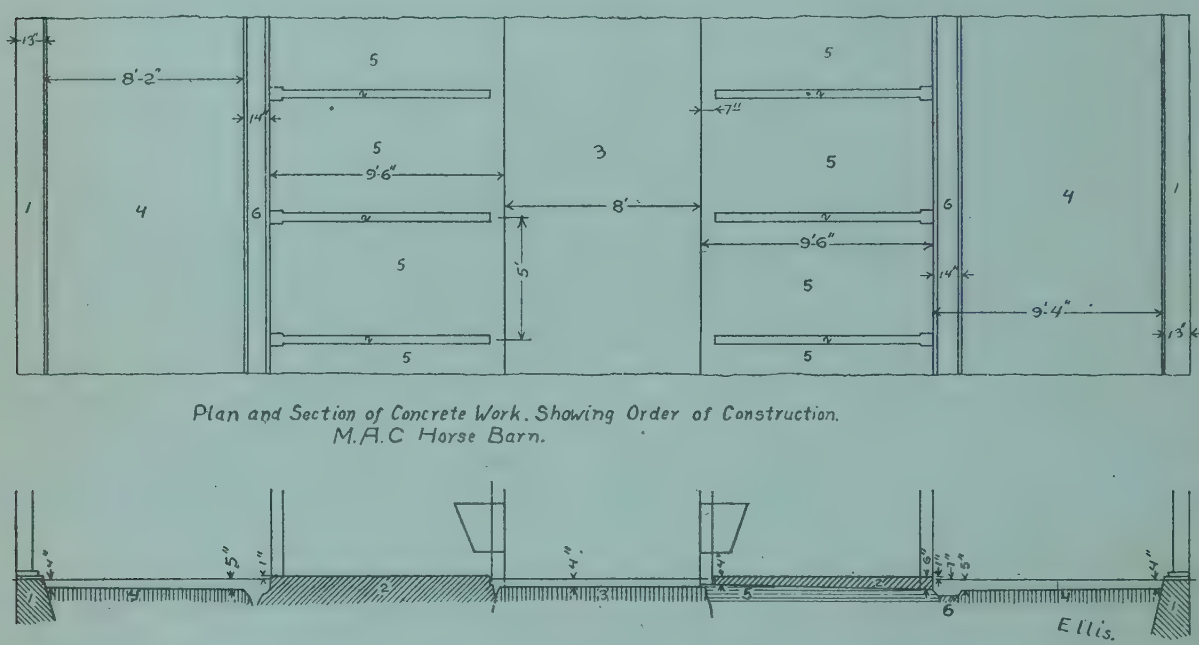


Fig. 14. 2 shows the piers carrying the stall walls. 3 is the feed alley floor. 4 is the floor back of horses. 5 is the stall floor. 6 is the gutter.

A form was set up in each case to mold the floor at the edge of the gutter.

Before the finishing layer hardened the surface of the rear half of the stall door was grooved as shown in Fig. 15 to prevent the horses from slipping.

After the completion of the stall floors the gutter floors (6 Fig. 14) were laid. Here again a template was used to strike off the material of the floor to secure the proper depth of gutter.

The common stalls,* of which there are eighteen, are single stalls. They measure 9½ feet in extreme length, and 5 feet wide from center to center of partitions. The rear posts are of oak, 6x6 inches, and are grooved to a proper height on the inside to receive the partition frame. The front posts are built up of two pieces 2x6 inches, enclosing one piece 2x4 inches, all southern pine, put together to leave a 2 inch groove in the rear side to receive the frame of the stall partition. Above the partitions, a piece of southern pine is inserted into the groove to make the post solid.

*The dimensions, mangers, and partitions of these stalls are copied after those in the horse barn of Hon. A. P. Bliss of Saginaw, Michigan.

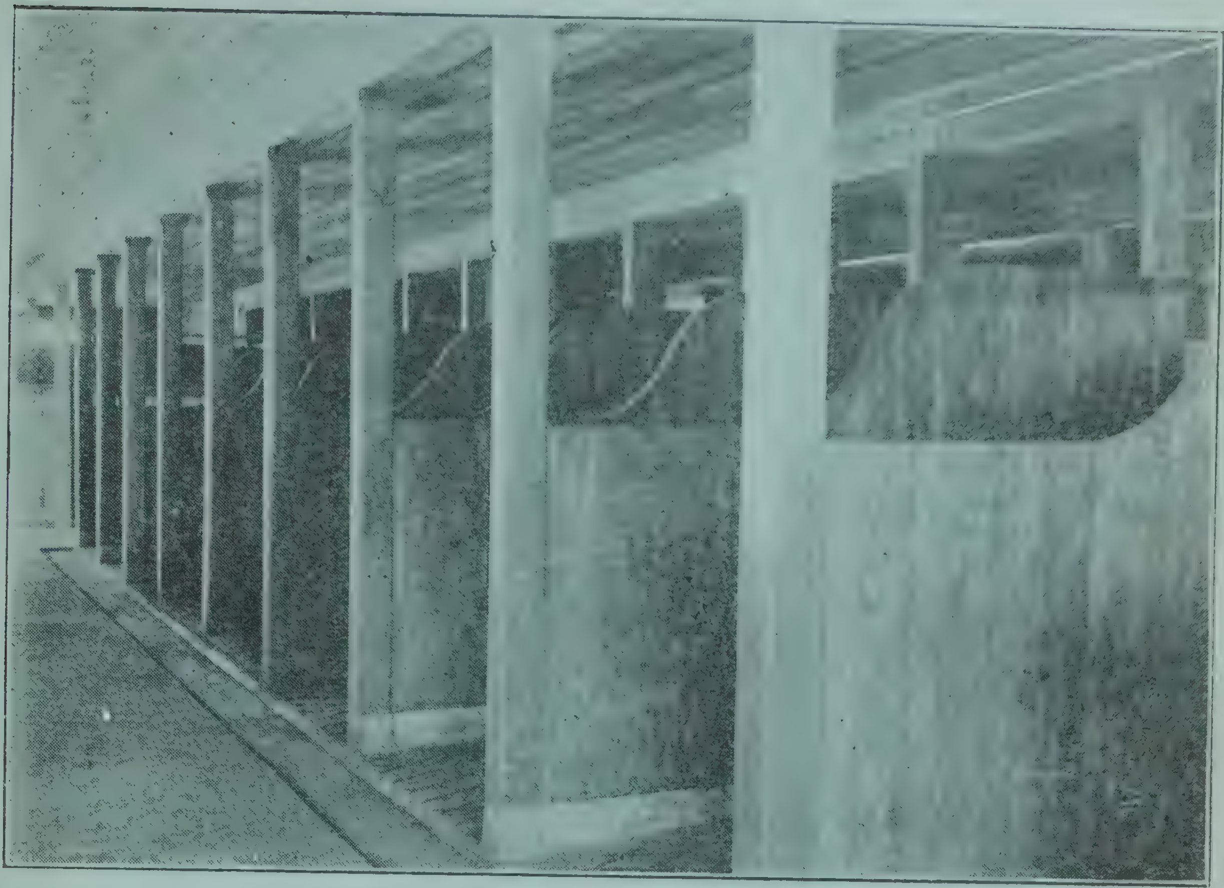


Fig. 15. The common stalls.

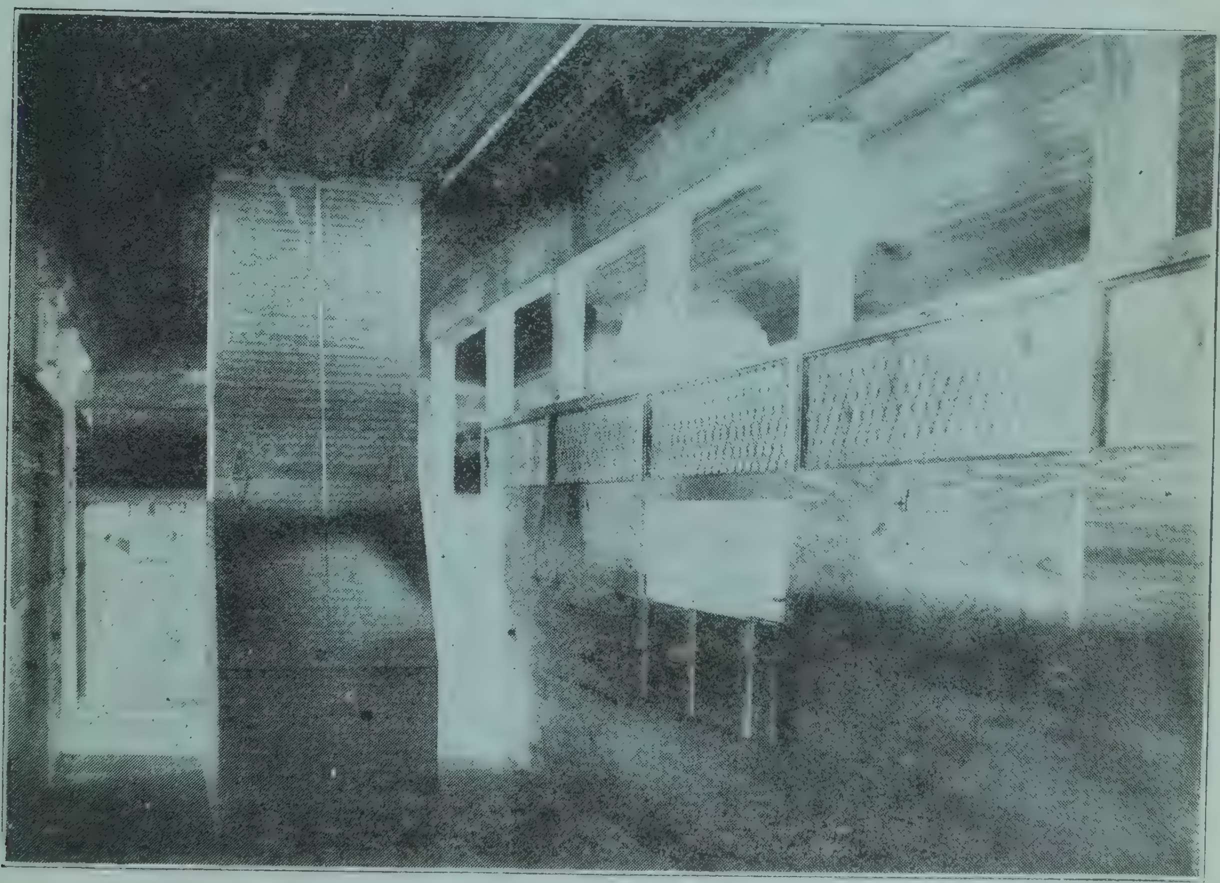


Fig. 16. Stalls as seen from feed alley. One of the feed doors is open.

The partitions, as shown in Figs. 13 and 15, are 4 feet high at the rear and 6 feet high at the front. They consist of a solid frame of 1½ inch southern pine flooring resting on the top of the cement pier with their ends carried in the grooves in the posts above mentioned. To this frame is nailed on each side ¾x2½ inch maple flooring. The top of the partition, curved as shown, is covered with 3 inch No. 16 strap iron. The iron is screwed to the frame and, at proper intervals, to the ends of the flooring.

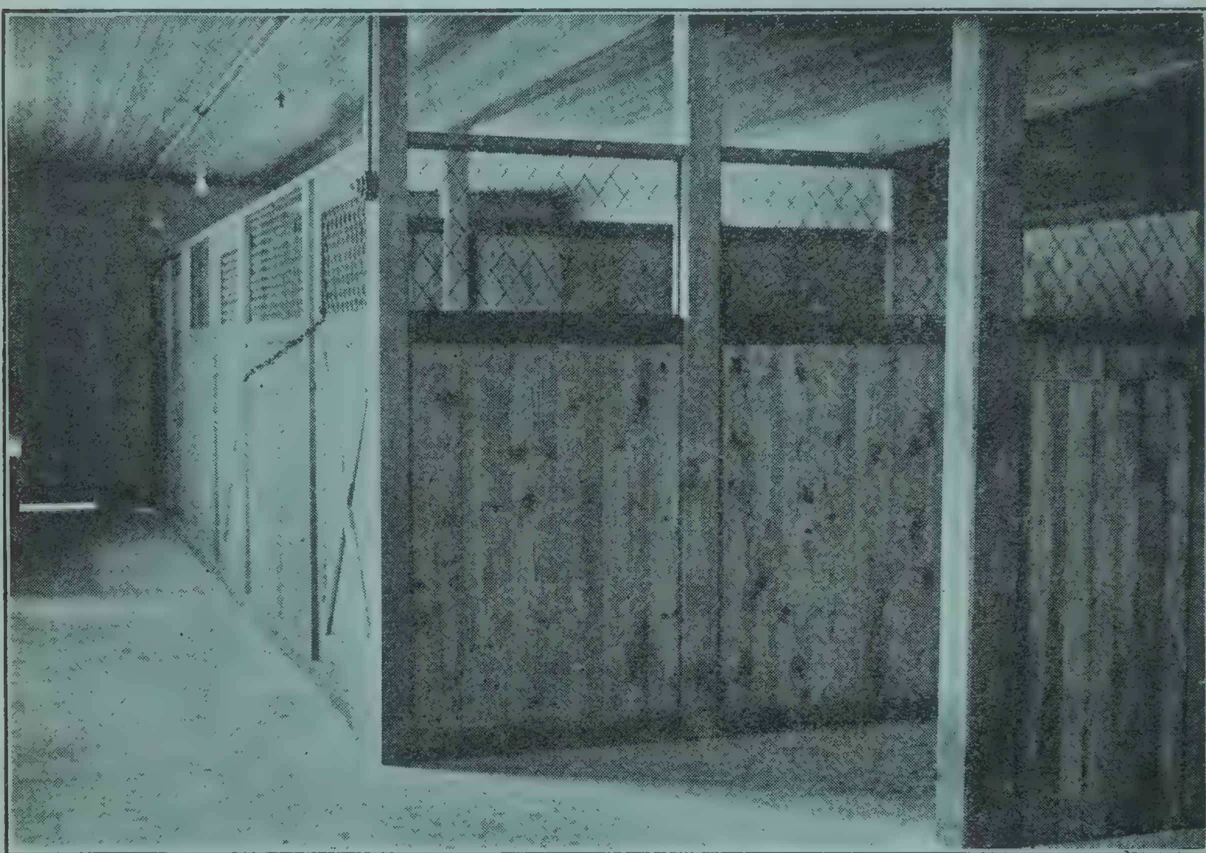


Fig. 17. View of box stalls.

The mangers and feed boxes are made of 1½ inch southern pine flooring. Their dimensions are shown in Fig. 13. The mangers are held in place by maple cleats screwed to the partitions.

A partition built to the posts of the stalls separates the stalls from the feed alley. A view of this partition is shown in Fig. 16 and the details are shown in part in Fig. 13.

The feed doors, fifteen and one-half inches high and fifty-eight and one-half inches long, are separated from each other by one and one-half inch strips, are hinged to drop and when closed are held shut by small metal door latches.

As shown in Fig. 16, there is carried in the upper part of the partition a woven wire guard fourteen and one-half inches by fifty-eight inches. This admits the free passage of both air and light.

Upon the upper edges of mangers and feed boxes are screwed strips of one and one-half inch number thirteen strap iron to prevent the horses from gnawing and otherwise marring these parts.

The box stalls are five in number. Their arrangement and sizes are shown in Fig. 11.

The outer walls of the stalls are five feet high, surmounted by a 22½ inch woven wire guard and frame as shown in Fig. 17.

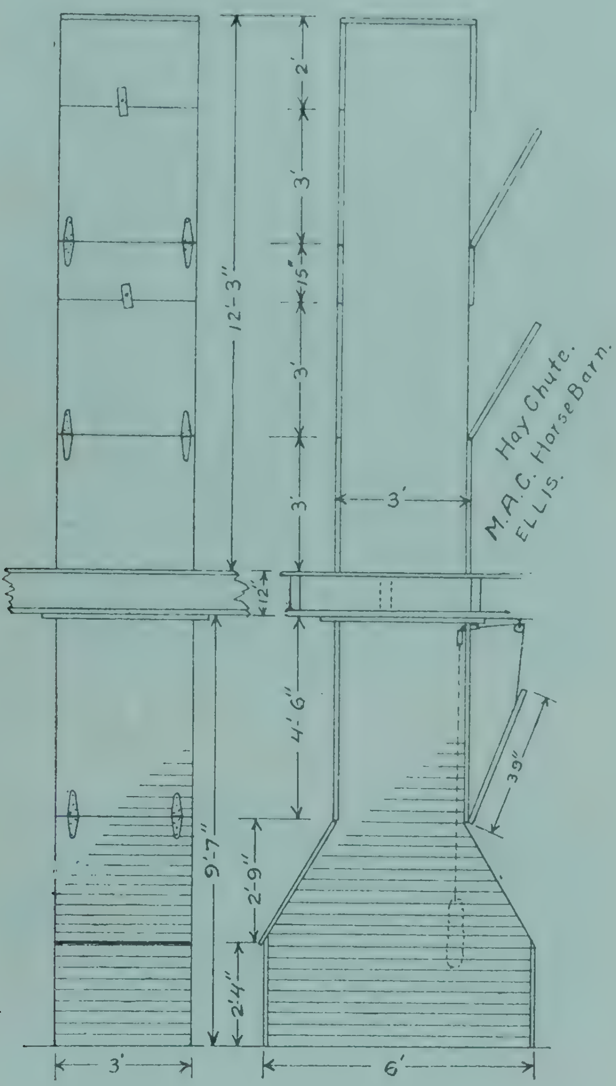


Fig. 18.

The partition walls between the box stalls are seven feet high. Both outer and partition walls are of 1½ inch southern pine flooring carried by upper and lower rails of oak, 4x4 inches, grooved to receive the flooring. The lower rail rests upon the cement floor and is held in position by half-inch iron pins set in and rising 1 inch above the cement into the rail and by having its ends nailed to the posts.

The mangers in these box stalls are in every respect like those in the common stalls except that they are but 4 feet long.

Doors in the wall over each manger, 16x28 inches about, permit the placing of feed in manger and box.

As shown in Fig. 11, the two rows of horses face each other across a feed alley 8 feet in the clear.

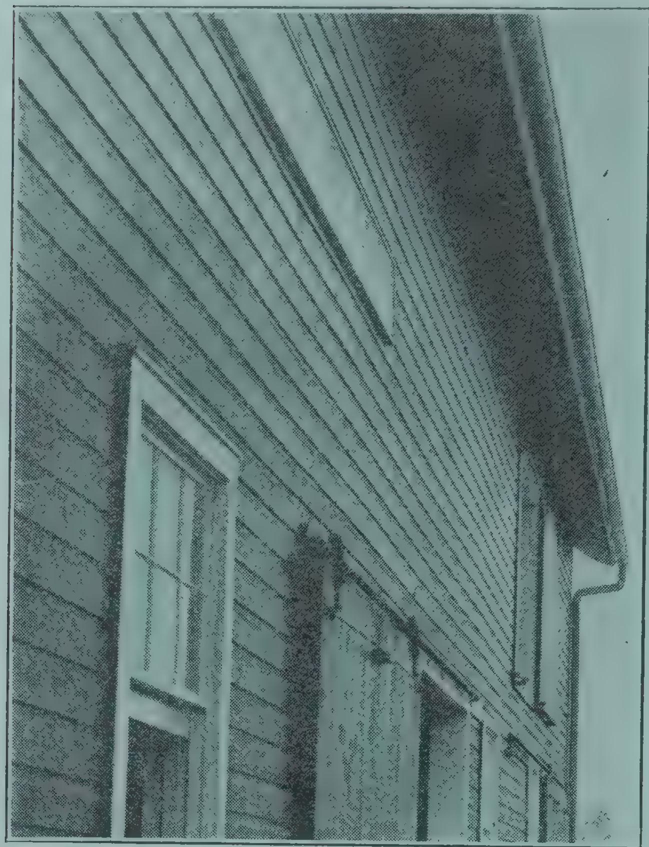


Fig. 10.

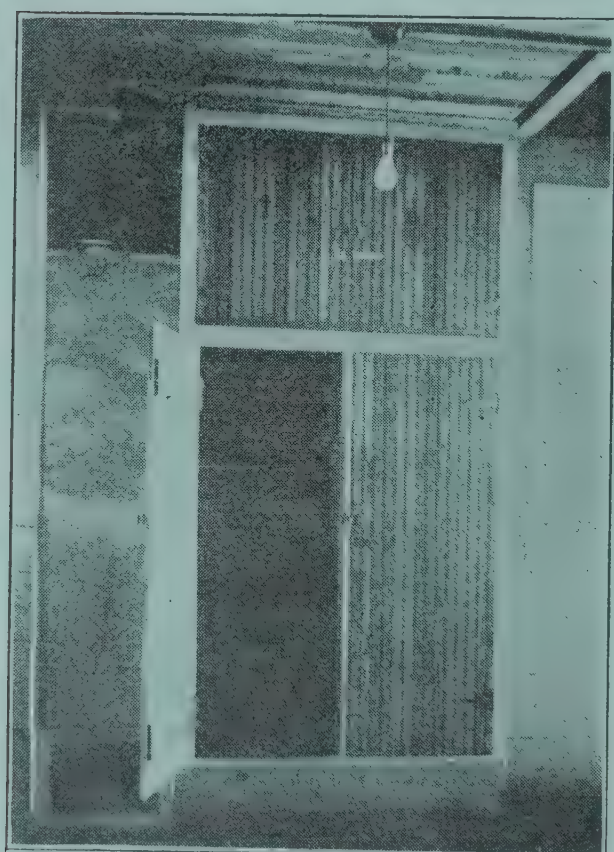


Fig 19

The hay chutes are shown in Fig. 18. These are planed so that hay can be gotten from the mow to the first floor and into the mangers without filling the air with dust and without littering the floor of the feed alley with dirt, leaves, etc. The dimensions are shown in the figure.

Canvass chutes are used for conveying bedding from the mow to the first floor. These can be folded and hung back out of the way when not in use.

Back of the stalls and fairly distributed are four double cupboards on each side for harness and above each of these, smaller double cupboards for miscellaneous purposes. The harness cupboards, or lockers, are 4x6 feet and 18 inches deep. See Figs. 11 and 19.

At the east end of the upper floor is a granary 9x8x16 feet with three bins and a total capacity of 900 bushels. Spouts lead from these bins to the small feed-room on the lower floor. See Figs. 20 and 21.

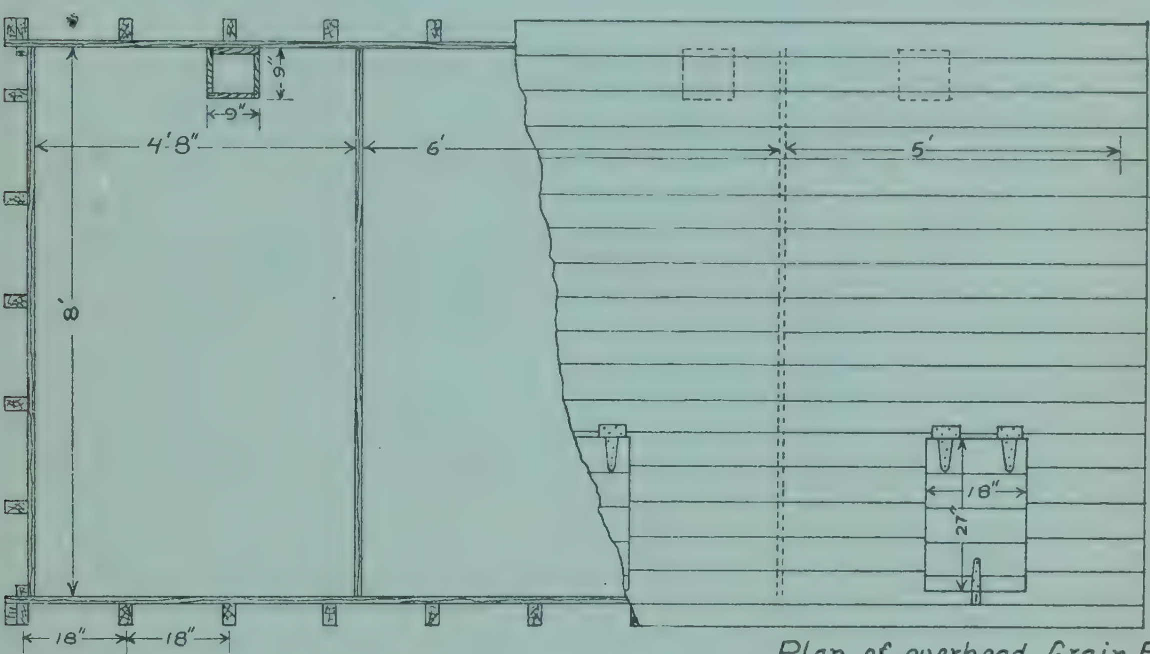


Fig. 20.

Figures 11 and 22 show the plan for watering. Two galvanized iron tanks 2x5 feet are placed as shown and are connected by pipe (c) so that tank (b) is supplied with water from tank (a), which in turn is supplied from the hydrant shown in figure. Tank (b) is connected with a sewer by a waste pipe(d). The plug (e) consists of a piece of gas pipe threaded into the end of the waste pipe and therefore answers the purposes of plug and overflow.

A system of ventilation is provided after King's plan. To remove the air from the stable there are four flues 12x21 inches built of sheet iron. They are set into the walls, two on a side, and run up in pairs, each flue pairing with the one opposite it. The flues of a pair after passing up into the mow follow up just under the roof and meet under a cupola, unite and extend up into the cupola half way to its top. These flues take the air from just above the foundation wall, (see a in Fig. 19), but are provided with registers 18x18 inches just

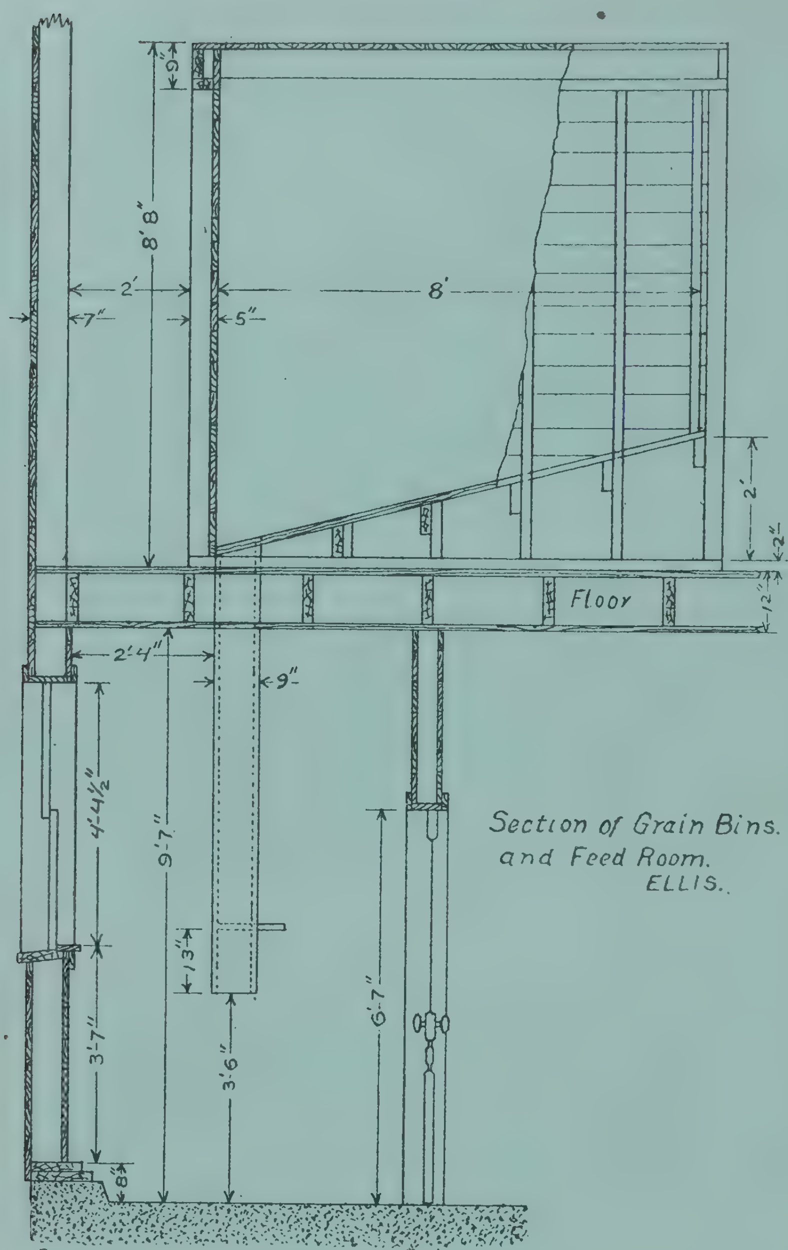


Fig. 21.

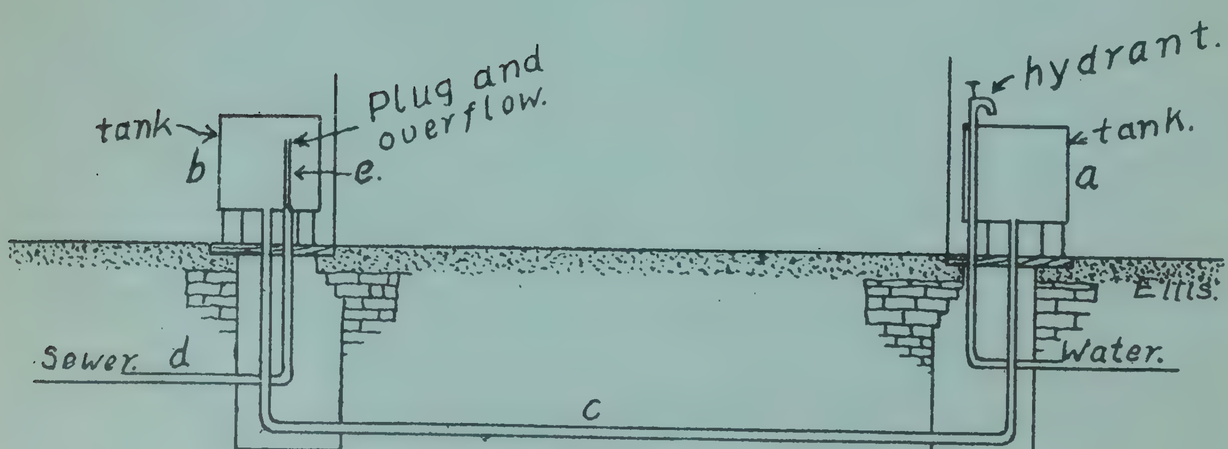


Fig. 22. Watering system.

below the ceiling which can be opened when it is desired to remove the warm air from near the ceiling. See B in Fig. 19, see also Fig. 23.

Ten intakes are provided, for the ingress of fresh air. These are 6x23 inches, are lined with sheet iron and each occupies the space between the inner and outer walls and two adjacent studs. Each opens to the outside at the bottom and to the inside at the top. Each is provided with a register 10x17 inches over the opening into the stable. These registers are for the control of the air on windy days. See Fig. 23. Intakes are shown near foundation walls in Fig. 4.

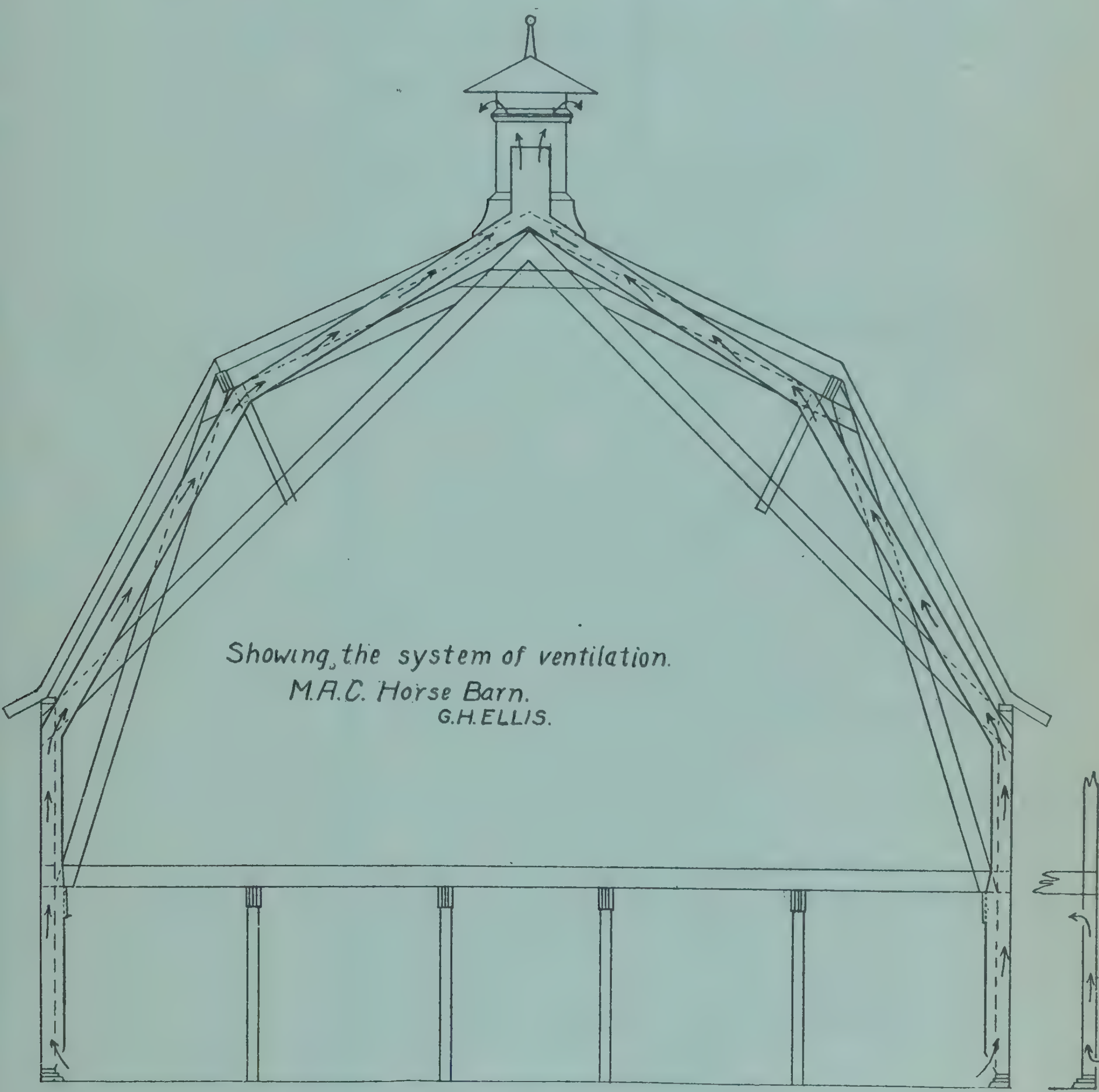


Fig. 23.

Fig. 4 shows a view of the barn complete looking from the northeast.

Fig. 24 shows the plan of the old horse barn. The five box stalls on the east side of the building, while possibly planned originally for horses, were of late years used for cattle. This fact probably accounts for the solid partition which is shown to separate the horse stalls from the alley which is marked "blind alley."

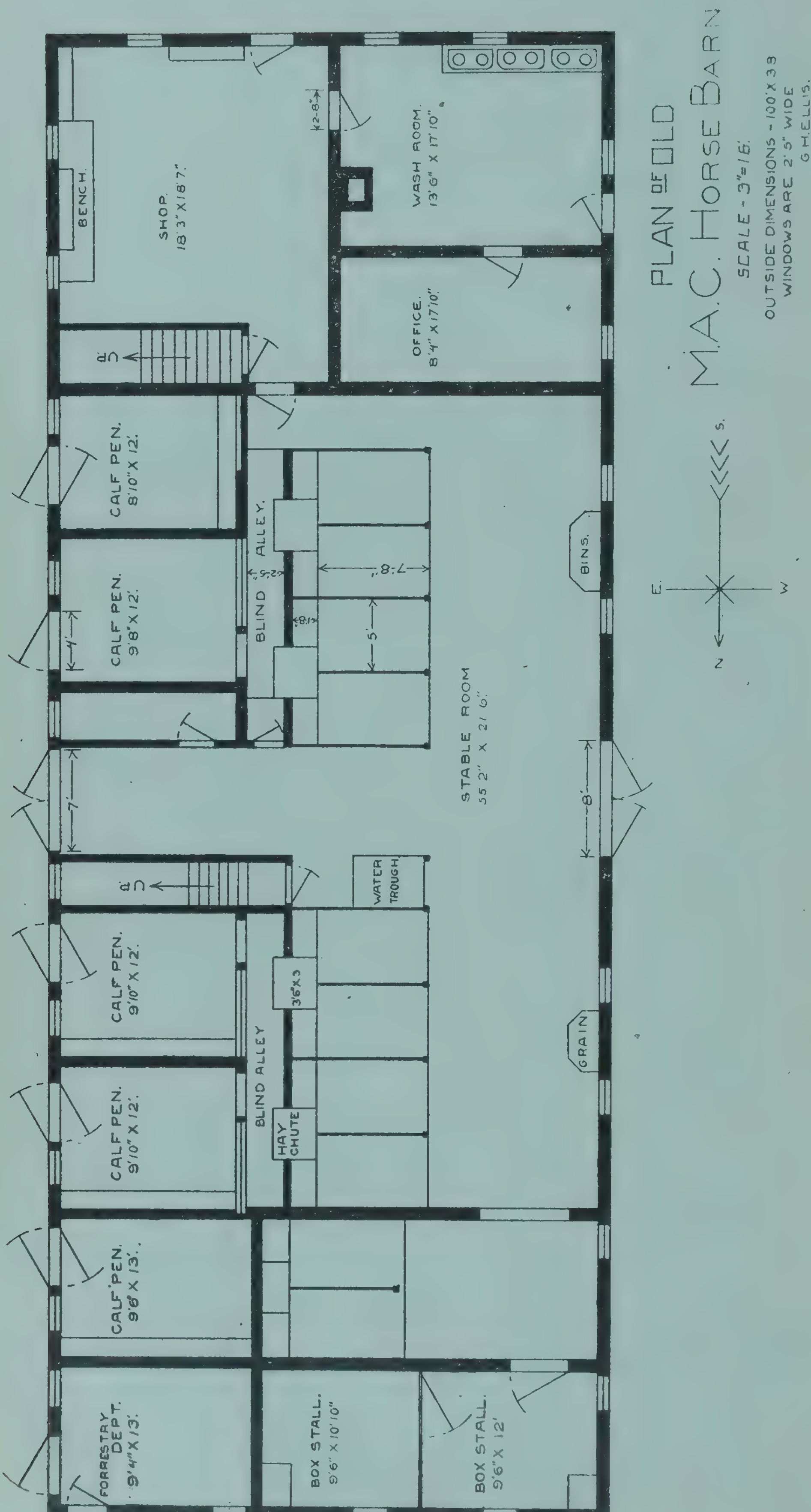

PLAN OF OLD
M.A.C. HORSE BARN
SCALE - 3"=16'
OUTSIDE DIMENSIONS - 100' X 38
WINDOWS ARE 2'5" WIDE
G.H.ELLIS.
SHOP.
18'3" X 18'7"
BENCH.
WASH ROOM.
13'6" X 17'10"
OFFICE.
8'4" X 17'10"
2-8"
UP
CALF PEN.
8'10" X 12'
CALF PEN.
9'8" X 12'
BLIND ALLEY.
7'8"
5'
4'
7'
STABLE ROOM
55'2" X 21'6"
BINS.
8'
UP
WATER TROUGH
CALF PEN.
9'10" X 12'
3'6"X3
BLIND ALLEY
GRAIN
CALF PEN.
9'10" X 12'
HAY CHUTE
CALF PEN.
9'6" X 13'
FORRESTRY DEPT.
9'4" X 13'
BOX STALL.
9'6" X 10'10"
BOX STALL.
9'6" X 12'
S.
E.
W.
N.

Fig. 24.

The box stalls are shown to be separated by solid partitions, the only light coming to the stable by way of the one window opening into the stall and the doorway, when the door was open.

Of the two box stalls in the northeast corner, used for horses, *one* was reached by passing through the other.

Observe, too:—

(1) That all the horses in stalls faced a solid partition.

(2) That even if this partition were removed, that part of the barn would still be poorly lighted because of the plan of the box stalls.

(3) That because of the construction, the circulation was bad.

(4) That with two exceptions all box stalls could be reached only from the outside, and in the case of the two exceptions one of the stalls could be reached only through the other.

(5) That the "alley" was waste room.

In the new horse barn with practically the same floor space per horse, for the horses in the common stalls, the ventilation and light in both summer and winter are highly satisfactory, and the arrangements for feeding and otherwise caring for the horses, it would seem, could hardly be improved upon.

The box stalls, too, are not only conveniently accessible, but they are also well lighted and well ventilated.

THE COLLEGE SILOS.

At the present time we have at the college three silos. Two of these are of the so-called all wood type, and one is of the solid cement type.

The larger of our all wood silos, Fig. 25, was built in the summer of 1900 and is filled this year (1907) for the eighth time. It stands 32 feet above the foundation, has an inside diameter of 20 feet, and holds from 160 to 170 tons of silage, depending upon the manner of filling.

The foundation is of cobble stone laid in cement mortar, and stands about 8 inches above the ground and 10 inches above the cement floor within.

The construction of this silo differs from the general plan of all wood silo construction only (1) in having the sills and plates sawed to the curve of the silo wall, and (2) in having a plate set between the two tiers of studding instead of having the two lengths spliced, which would have given an unobstructed air space from sill to upper plate. Splicing the studs is the more desirable way of doing.

The sills consist of a single thickness of 2 inch stuff, 4 inches wide after sawing.

The plates consist of two thicknesses of 2 inch stuff sawed to the same width as the sills and set to break joints.

The sills are secured to the foundation by bolts which were set in the foundation during its construction.

The studs are 2x4 inch hemlock set 12 inches apart, center to center. Next to the barn two studs made of two 2x4's each are set to give a continuous doorway, 26 inches wide, from sill to upper plate.

To prevent the door frame from spreading, bolts of ⅝ inch iron are placed at intervals of 30 inches from bottom to top. These bolts pass through the center of the door frame and far enough beyond the second stud to receive a 2 inch by 4 inch No. 10 steel washer and a large nut.

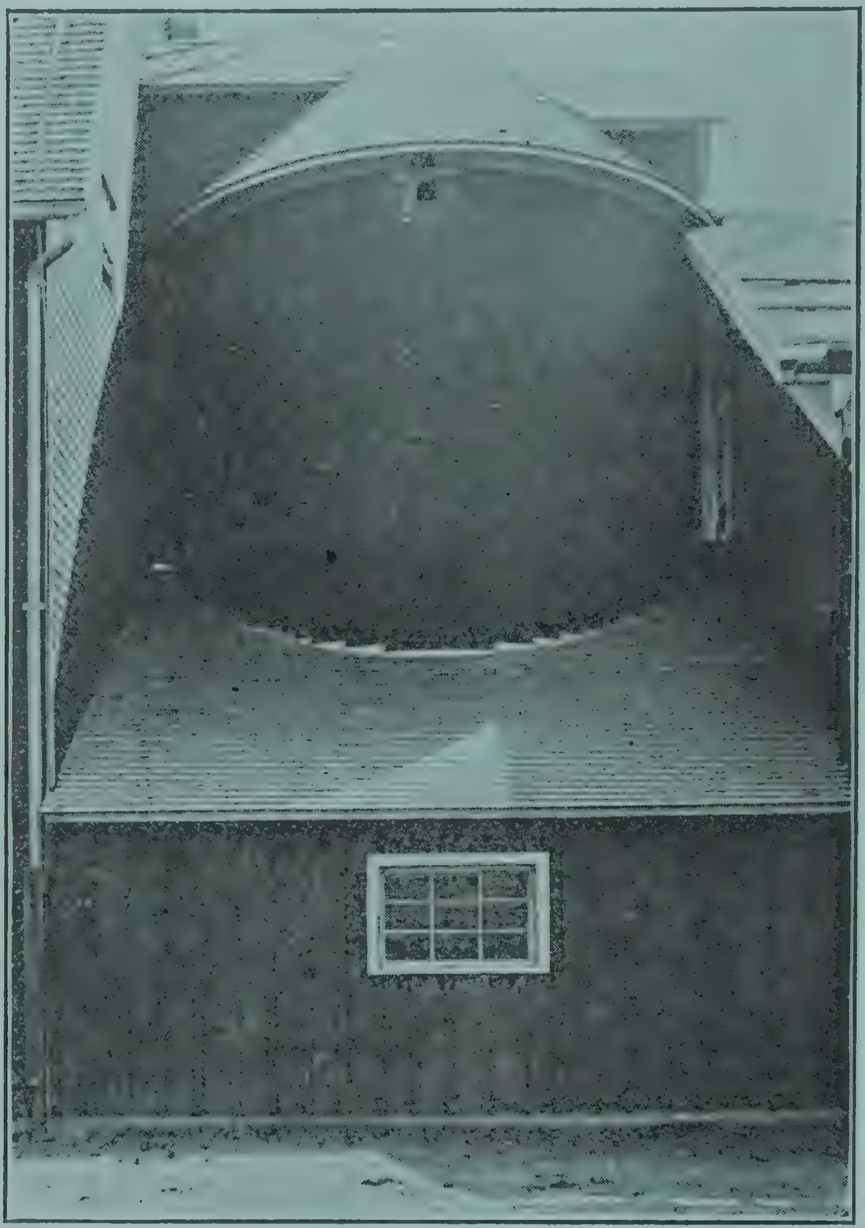


Fig. 25. All wood silo, built in 1900.

The inner wall consists of two layers of ½ inch by 4 inch basswood sheeting with a layer of tar paper between. In the construction, the first layer was laid and well tarred with coal tar on the inner surface. Over this was tacked the layer of tar paper which was then well coated with tar. The second layer of sheeting was so laid over this paper as to break joints with the first layer, and was later treated to a heavy coat of coal tar. Both layers of sheeting fall one inch short of outer edge of the studs bearing the door frame.

The outer wall consists of 3 ½ inch beveled basswood siding. The lower inner edge carries a ½ inch rabbet, which makes it possible to use beveled siding on cylindrical walls.

The roof is carried by 2x4 rafters, set 24 inches apart, center to center, on the plate, and converging to the center, or peak. Short pieces of 2x4 are nailed at intervals from plate to peak and at right angles to the rafters to carry the sheeting. The sheeting is set at right angles to the plate; otherwise the sheeting and shingling does not differ from that of other roofs.

A dormer window, facing the south, was originally used for ventilation and to admit the cut corn and other material to be ensiled. The enclosing of the silo by other buildings recently has made it necessary to cut a hole in the west side just under the eaves to admit cut material.

The doorway is cased with a single $\frac{7}{8}$ inch piece placed flush with the inner edge of the stud and extending out just beyond the outer surface of the siding, which is laid against it. This piece acts as both jamb and stop.

The doors consist of $\frac{7}{8}$ inch boards placed against the jambs and uncovered portion of the stud, after the manner of placing bin board in our granaries. As the filling progresses the boards are set in place, and against these are tacked 34-inch strips of number 28 galvanized sheet iron, which overlap each other by about an inch and reach about four inches beyond the edges of the doors.

In this silo we have kept silage to the third season.

For ventilation between the walls of this silo an inch hole was bored into each space between studs (1) through the outer wall near the sill, and also (2) through the false plate separating the lower from the upper tier of studs. It has never proved satisfactory.

The question of the desirability of basswood for silo lining or sheeting should be considered at this point. This silo has been built seven years. In the upper two-thirds of the wall the basswood sheeting is apparently, at this time, in a good state of preservation; but in the lower portions of the wall where the silage has remained in contact with the wall well into or even through the summer, a good deal of rotting has occurred. Indeed, near the sill, several pieces of sheeting have had to be replaced.

The other all-wood silo, Fig. 26, was constructed in 1897. In the fall of 1904 it was moved some 300 feet and placed upon a new foundation.

This silo has an inside diameter of 18 $\frac{1}{2}$ feet, and a height of 26$\frac{1}{2}$ feet above the foundation upon which it rests. The foundation in turn has a height of 6 feet above the silo floor, thus making the total height of the silo about 32 feet. The top of the foundation wall stands about 12 inches above the ground.

The capacity of the silo is 130 to 150 tons, depending upon the manner of filling.

In a few particulars this silo differs in construction from our other all-wood silo.

The studs stand 12 inches apart, center to center, as in the other; but the pieces of each stud, 12 feet and 14 feet in length respectively, are placed end to end and spliced by nailing on each side of the joint a three foot strip of 2x4. A strip of 1x4 would have answered just as well. In setting up the studs, the alternate ones had their 14 foot ends set downward.

The doorway, which is continuous as in the other, is kept from spreading by ¾ inch round bolts set 36 inches apart.

The inner wall is composed of two layers ½ inch by 3½ inch southern pine, with a layer of tar paper between, but put on in the same manner as was the basswood sheeting in the other silo. After ten years this sheeting seems to be in a perfect state of preservation.

The roof differs in its construction from the other merely in having

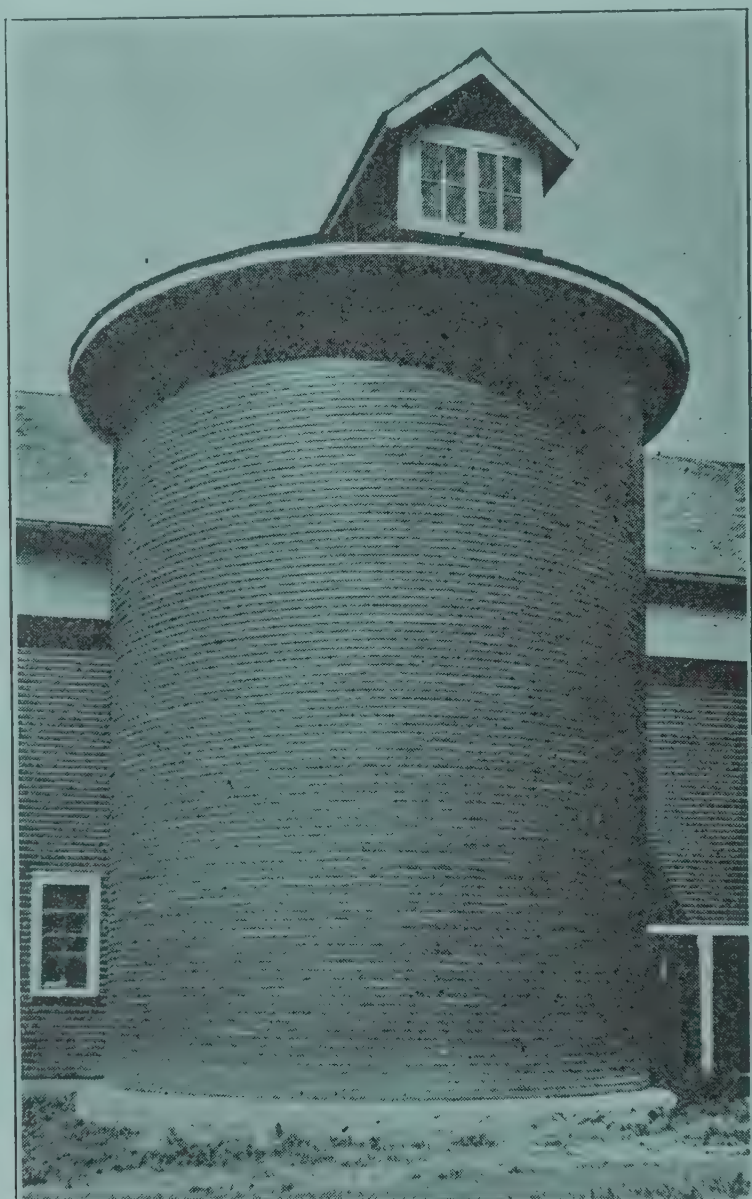


Fig. 26. All wood silo, built in 1897.

the rafters set 18 inches apart, center to center, on the plates instead of 24 inches apart.

Ventilation between the walls is secured by means of 1 inch auger holes bored from the outside into each of the spaces between the studs at the bottom, and from the inside of the silo into these spaces at the top. While this does not provide for the freedom of air movement required by Prof. King and other authorities on silo construction, it is helpful in preserving the walls of the silo.

The cement silo, Fig. 27, is of the solid wall type. It has an inside diameter of 15 feet and a height of 31 feet, standing about 5 feet in

the ground and about 26 feet above ground. When well filled it holds about 90 tons of ensilage.

This silo was built in the summer of 1905.

The wall is 10 inches thick from the ground to plate.

The openings for the doors are 24 inches wide and 36 inches high,

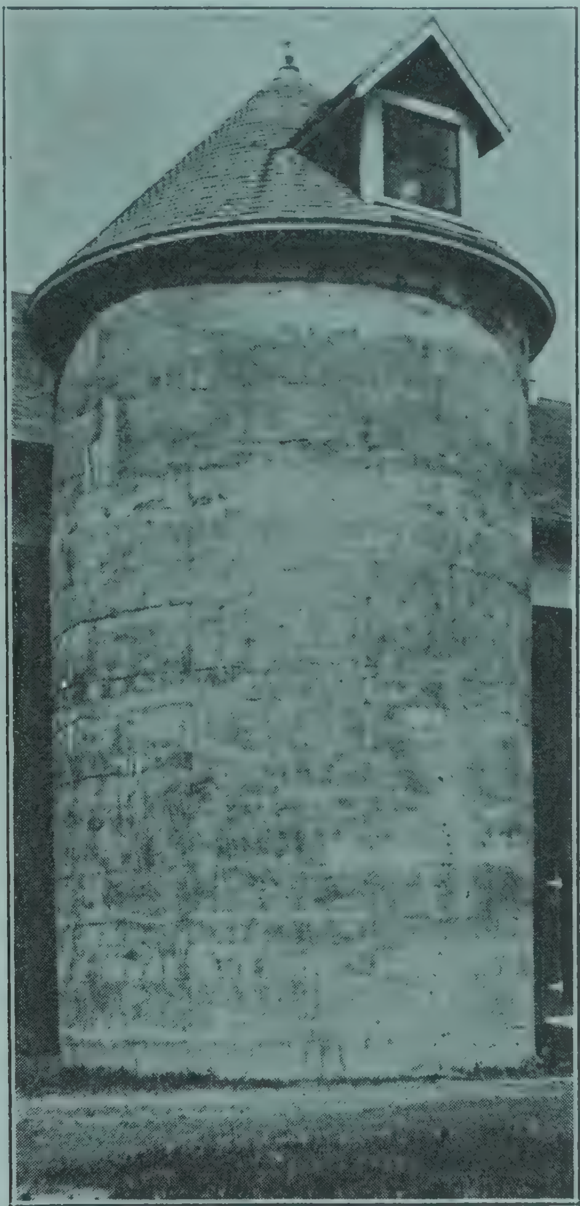


Fig. 27. Solid wall cement silo, built in 1905.

and are 2 feet apart. Only the top opening carries a frame. Each of the other openings carries a shoulder sufficiently deep, moulded into the inner side of the wall, to carry a door of 1-inch material flush with the inside wall. This door, made of inch material (flooring in this case) held together by cleats is set in place in the doorway, and against the inner side is placed, in the same manner as in the other silos, a piece of galvanized sheet iron sufficiently large to lap two inches beyond the doors, thus preventing the passage of air through and about the door.

In building that part of the wall below ground a circular trench

14 inches wide and with an inside diameter of 15 feet was dug, 6 feet deep. The digging of such a trench was made possible by the fact that the ground here was all clay. This trench was used as a form into which to build the below ground wall with the exception indicated below. After the completion of the upper wall the earth inside was excavated to the depth of the wall, 6 feet, and a cement floor was laid.

In building the wall above ground an inner and an outer form were used, each 4 feet high. The inner form was made in two sections of 2x6 hemlock nailed to wooden half circles. One piece of 2x6 was loose, to be removed to loosen the form before lifting and to bring it back close to the inner surface after lifting.

The outer from was made of 4-inch hemlock strips held together, in part, by a 28 inch strip of sheet iron covering a little more than the upper half of the inside, and in part by two iron hoops with turn-buckles. The hoops with turn-buckles performed the further office of drawing the outer form tightly against the outer surface of the wall after each liting of the form.

The outer form was set 2 feet down into the trench and properly adjusted to build the upper 2 feet of the below ground part of the wall. The inner form was then properly set in place and the upper 2 feet of the below ground wall and the first 2 feet of the above ground wall was set up. From this point until the wall was completed, the outer form was raised about 24 inches each time, while the inner form was raised at the rate of about 48 inches, i. e., its full width. By raising the outer form at the rate of 24 inches each time each section of wall was set up against sheet iron which insured a smoother wall than could be had if set up against wood.

Wooden forms were used to shape the openings for the doors.

To reinforce the walls, pieces of No. 9 fence wire were built into the concrete at intervals of about 1 foot.

In sections of the wall between doors these pieces of wire extended completely around the silo and were so built into the concrete.

In those sections which were to contain doors a 4 foot piece of ¾ inch gas pipe was set up about 6 inches out from where the door should be, one on each side, and so that one end of each piece stood 6 inches above and one end of each 6 inches below where the door should be. The ends of the pipes extending above the door were then tied together with a few twists of wire as were also those extending below. To these pieces of pipe were tied the ends of the pieces of wire which were to be built into the walls of the section, and so were built into place.

The concrete used in the construction of the wall was made of mixed sand and gravel, and a good Portland cement. The wall is of the same thinkness from ground to plate, 10 inches, but the richness of the concrete varies. The portion of sand and gravel to cement in the first 13 feet above gruond is 6 to 1. In the upper 13 feet the proportion is 7 to 1.

After completion both inner and outer surface of the wall was "whitewashed" with a rich cement wash.

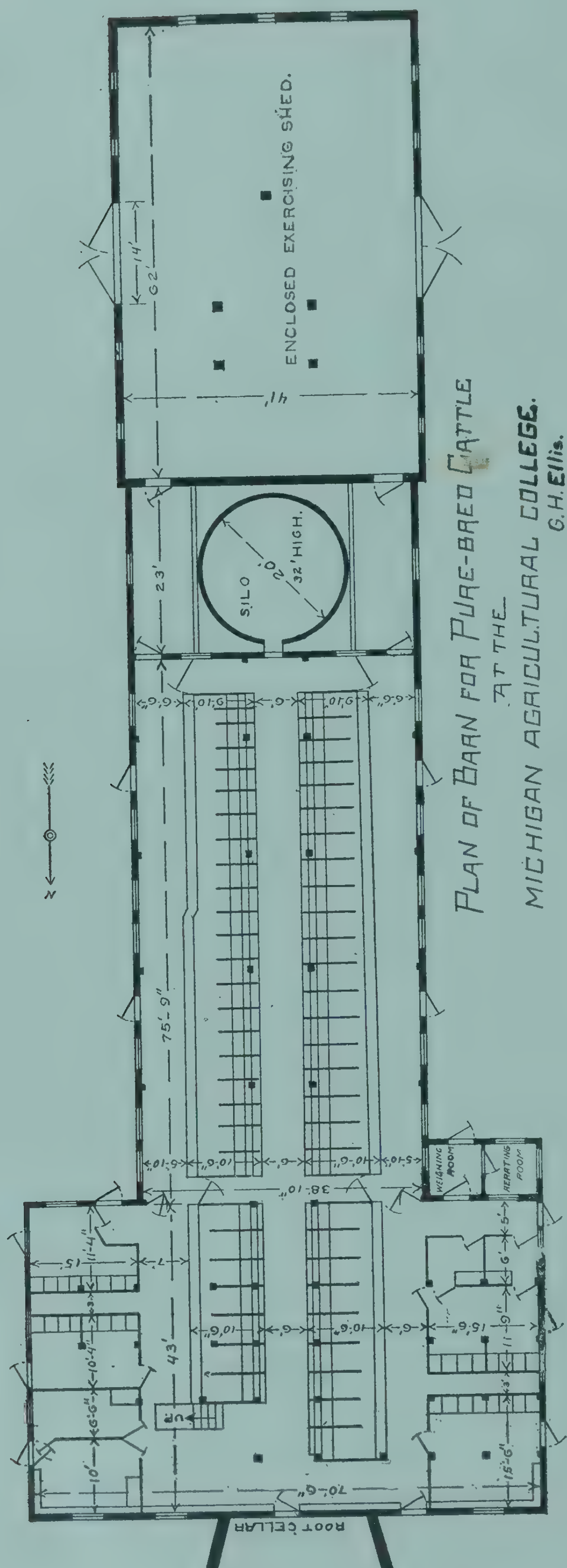
The wall is surmounted by a plate made up of 4 thicknesses of ⅞ inch hemlock boards, sawed to the circle of the wall and held in place by bolts built into the wall. This plate carries a roof built in the same manner as that on silo 2.

DAIRY BARN.

Note.—In presenting the various plans of stock barns they are not offered as models; we built according to our particular needs. They may offer suggestions to others in providing for their specific needs.

Figure 28 shows the ground plan of the dairy barn and silo erected in 1900. The enclosed exercising shed, which was originally the beef cattle barn, was moved to the present position during the summer of 1906. The main part of the dairy barn which is a T shaped structure is 44x72 feet, and the annex 40x75 feet. At the present time the main building is stabling all the pure-bred beef cattle and dairy calves; dairy cows and heifers are kept in the annex. The entire barn has stalls for sixty-five cows and heifers, and the box stalls accommodate thirty-six calves and young cattle, or a total of about one hundred head. It is the intention to remove the pure bred beef cattle from this building to the grade beef herd barn about one year hence, when the experimental work with the latter is completed, thus giving up all the room of the dairy barn to dairy cattle. The main part of this barn was completely remodeled during the spring of 1905. The east end of the main building, 16x44 feet, projecting beyond the annex was used for two bull stalls, a herdsman's room and a milk room; the balance of this proportion of the structure was utilized by fifteen box stalls of various sizes, none of them having direct access to yardage. In the remodeling, the capacity of the main barn was more than doubled as it now handles sixteen stalled cattle and thirty-six calves and young cattle, all of the latter having direct access to yardage. The calf stanchions for thirty-two head are fully described in connection with Fig. 36. The two rows of stall fittings are also described in connection with Fig. 35. These stalls are about 5 feet 9 inches from manger to gutter, and from 3 feet 9 inches to 4 feet wide from center to center, to accommodate 1,200 to 1,500 pound cows either suckling their calves or being milked; the stalls are very satisfactory in every respect. On the north end of this barn there is a root cellar 12x18 feet, made by walling in both sides of the gangway leading into the ground floor above. It was somewhat difficult to keep the floor above this root cellar from leaking. The joists were covered with inch lumber, then a very liberal coat of tar and fine sand on which two inch planks were laid, they also being coated with tar and sand.

The annex to the main barn, which is 40x75 feet has been altered but very little since its original construction. The row of nineteen stalls on the west side decrease in size from one end to the other; on the north end they are 5 feet 8 inches from manger to gutter and 3 feet 10 inches wide from center to center; the south stall is 4 feet 9 inches long and 3 feet wide. In this row the animals are fastened at the neck to chains, reaching across the stall. The row of twenty-one stalls on the east side has been altered some, the stalls having been lengthened six inches from the north end to the jog in the gutter to accommodate a group of large Holstien cows. The north stall is 5 feet 9 inches from manger to gutter and 3 feet 6 inches wide; the south



ENCLOSED EXERCISING SHED.
SILO
20'
32' HIGH.
ROOT CELLAR
WEIGHING ROOM
AERATING ROOM
62'
14'
41'
23'
75'-9"
38'-10"
43'
70'-6"
PLAN OF BARN FOR PURE-BRED CATTLE
AT THE
MICHIGAN AGRICULTURAL COLLEGE.
G. H. Ellis.

Fig. 28.

stall is 4 feet 3 inches long and 2 feet 3 inches wide; there are several gradations between these two sizes. This row is fitted with swing stanchions. The manger bottoms were raised four inches above the floor instead of resting on it, this prevented securing more then three inches inside depth to the front of the manger, which is insufficient to prevent waste of feed. Most of the doors of this building are in two sections, upper and lower, with windows in the top half; as hereafter stated windows so placed are constantly being broken from slamming and the necessary light should be secured elsewhere. The doors all swing in against the sides of the door sills instead of on the top, which is a mistake, as snow, straw and manure is constantly collecting between the doors and sills, freezing to them and preventing them from closing perfectly. In some cases 4x4's have been imbedded in the cement floor and are now completely rotted away; it is advisable to keep all wood fittings above or on cement rather than imbed them in it, for in the latter case they decay quickly.

The enclosed yard 43x64 feet, at the south end of the dairy barn, is used in part for shed feeding, and in part for a manure shed. It is the intention to use it as an exercising yard for cattle and also a storage place for manure. It is connected with the dairy barn by covered alleys on both sides.

GRADE BEEF HERD BARN.

Fig. 29 shows the ground plan of the stable now being used as the grade beef barn; it is 45x80 feet and is joined to the grade dairy herd barn at the south end. In Fig. 1 this building is designated as the grain barn located a short distance northeast of the farm house; it was moved and refitted during the summer of 1905. This barn is fitted with stalls to accommodate thirty-three head of mature cattle and twenty head of calves and young cattle, making a total of fifty-three. The west elevation of this barn is shown in Fig. 38 and its lighting discussed in connection therewith. The south row of stalls has been illustrated in (1) Fig. 33 and the center row in (2) Fig. 33; the stalls of the north row are simply plain heavy ones to hold large experimental steers. The calf pen, manger and stanchion fixtures are illustrated and described in connection with Fig. 36. The entire floor, as in all our cattle stables, except the bull barn, is of cement. Stock scales were centrally located for weighing all experimental animals. The alleys, before and behind the rows of stalls, are a little over five feet wide; this may seem like a waste of space but is much more satisfactory than any less could be; as a general rule alleys are made much too narrow. So much room would not have been given up to the granary except for the demands of the experimental feeding work.

The continuous dotted line shows the location of the overhead steel track, to be installed, to convey the manure from the three rows of cattle and the three box stalls on the south end to the manure shed in the center of the court outside. The plan is to have the track pass out of the southmost door, only, toward the manure shed. As a similar

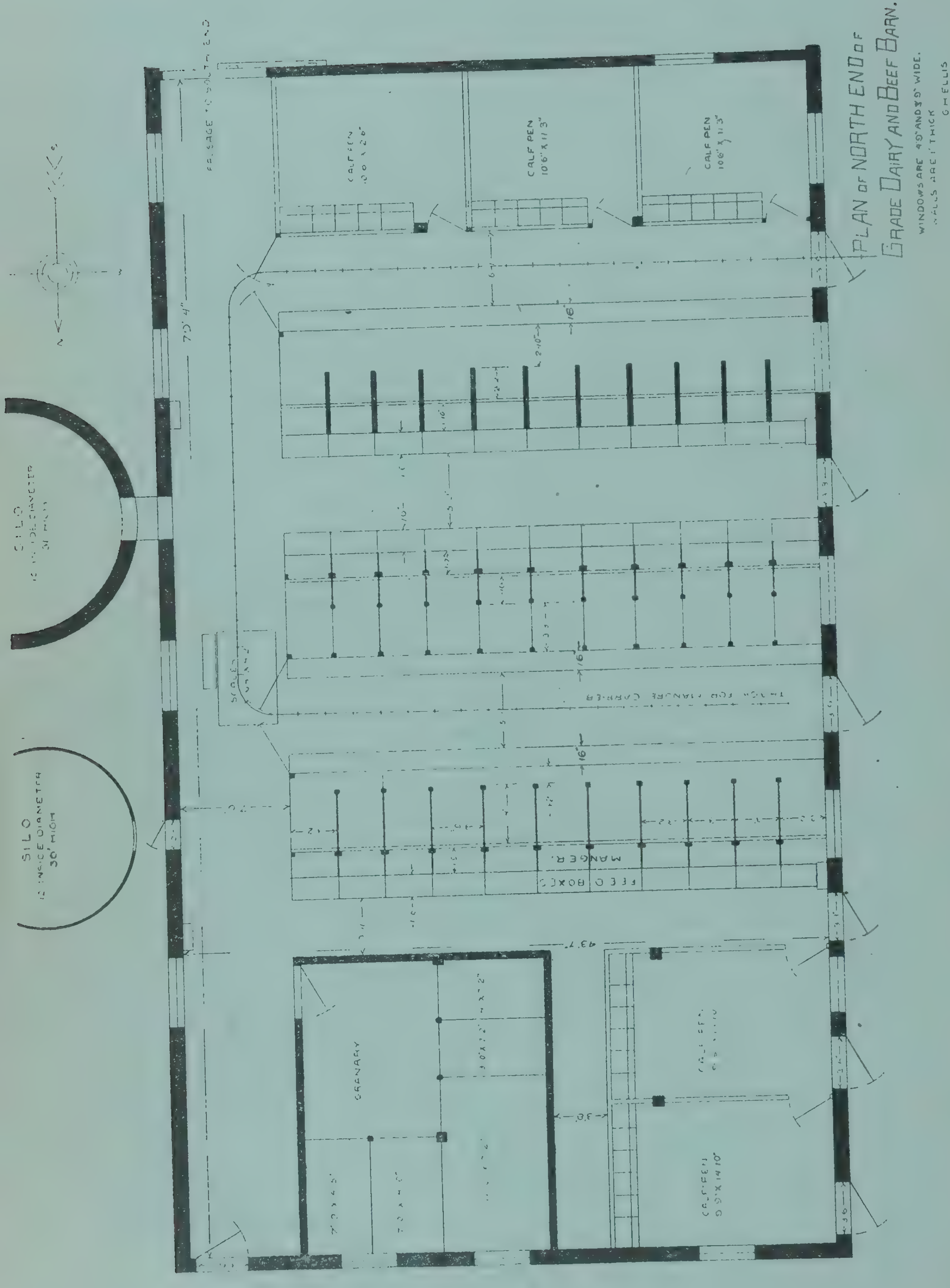

PLAN OF NORTH END OF
GRADE DAIRY AND BEEF BARN.
SILO
CALF PEN
GRANARY
MANGER.
FEED BOXES
SCALES

Fig. 29.

arrangement is planned for the adjoining barn this will permit two out going tracks near the center to do the work for the entire 150 feet of barn, and a long manure shed will not be necessary. The manure shed is to be 27x60 feet. The question may arise as to why the manure is not hauled directly to the field; throughout the greater portion of the year this is done, but there are times when there is no place to spread it and occasionally in seeding, haying or harvest, no time to haul it. The shed is intended to protect the two manure wagons into which the cars are to be dumped, and to take care of the manure which accumulates when it cannot be removed directly to the fields.

The cement and stave silos adjoining this building are described elsewhere in this publication. In all cattle barns the King system of ventilation has been used as described in connection with the horse barn.

GRADE DAIRY HERD BARN.

Fig. 30.

This barn, 45x70 feet, is now practically a continuation of the grade beef herd barn, the two forming an unbroken line 150 feet long. This barn and the adjoining silo were first erected just a few feet west of the large dairy barn, see Fig. 1, but were removed to their present location during the summer of 1904. This stable accommodates twenty-two head of mature cows, twelve yearling heifers, fourteen young cattle under one year, and twelve calves, making a total of sixty. The stable is if anything a little crowded, some of the stalls being a little small and the alleys too narrow. The stalls shown in the first and second rows from the north are of the type illustrated in (2) Fig. 33, but it is a marked improvement over these which were built first. The 3 feet 6 inch stalls are too wide for the 1000 pound cow and the inner bottom width of mangers all through the barn is too narrow by at least 4 inches. The third row of stalls from the north end is fitted with a one-half sloping partition and the animals are fastened around the neck with chains extending to cross bars bolted on each side of the stall. These stalls which are 4 feet 6 inches from manger to gutter are too short for animals over 750 pounds weight. The fourth row of stalls were fitted for skim milk calves under twelve months of age and answers well for confining them at night except that the mangers are too small. The twelve stanchions are used to accommodate the grade heifer calves of each year's crop as the males are vealed. The calf pen is divided according to the demand by movable partitions. The two calving pens for cows are used by calves during portions of the year when they are not in use for the purpose intended. The dotted line shows location of overhead steel track for manure carrier which is used for all four rows of stall cattle.

If the refitting work of this barn was to be done over again we would enlarge the third row of stalls for heifers and cut out the fourth row entirely, replacing it with larger box stalls in which groups of several young animals could be fed together loose, as described in Fig. 37.

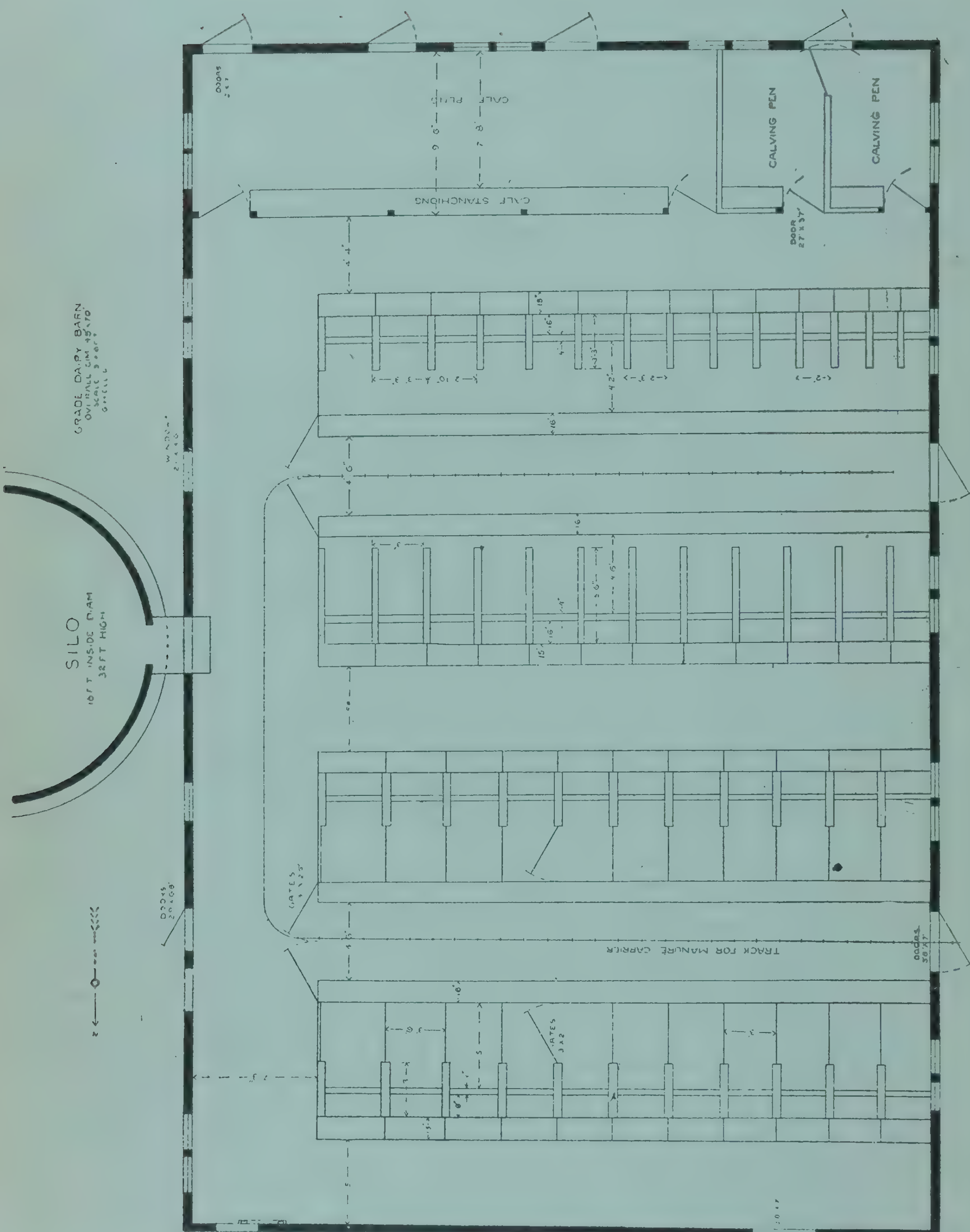

SILO
CALVING PEN
CALVING PEN
CALF STANCHIONS
TRACK FOR MANURE CARRIER

Fig. 30.

BULL BARN.

Figure 31 shows the barn now used to accommodate the herd bulls. Before the removal and refitting, this building was used for stall-fed steers, some calves and one or two bulls; its original location is shown in Fig. 1. The barn is 25x94 feet, and contains eight box stalls about 10x16 feet with a feed room of the same size but not separated from the alley by a partition. Each stall is entered from the alley by a four foot door fastened with a heavy wooden sliding bar. Leading from the stalls to the yards there are two doors; the outer one is the full height of the opening, but the inner one reaches but two-thirds the distance from the sill to the top of the casement. All doors are made of double inch material. In the partition directly over the manger there is a hinged door 2x2 feet, for each stall, to permit feed being supplied from the alley; there is also an opening in the front partition of each stall into which short pieces of iron pipe were fitted to permit the animals being seen without opening doors. The partitions between the stalls are double inch; they are six feet high coming down to within six inches of the ground. The alley and feed room floors are made of concrete while the stall floors are of earth. A water system has been installed by which there is a constant supply furnished in drinking basins, placed in the angle between the wall and the exposed end of each manger; in this position they are not subject to damage.

On the south side of the building there are nine windows each containing nine 8x10 inch lights; on the north side there are seven nine light windows each 6x8 inches. The windows are protected near the bottom by iron bars. Each pen has an adjoining yard of the same width as itself, except the one beside the feed room which is twice as wide; the yards are 36 feet long. The yard fences were built of old 1½ inch fence material from which the decayed ends had been removed. This material was placed vertically on one side of the posts and two strings of 2x12 inch plank horizontally in the opposite side to prevent the animals from pushing the upright boards off. These horizontal planks forming steps are a safeguard by which an attendant could get out of the yard easily and quickly should occasion demand it. In handling a vicious bull a cable is used. This cable is stretched from a post at the front of the feed manger through the box stall and across the yard and is then attached to a post eight or ten feet high fastened to the fence. A chain with snap is suspended from this cable by a ring running on it. The animal is fastened to the chain before being loosened from the manger and the opposite is done in securing him again for the night. The cable should not be low enough or the chain long enough for the bull to reach the ground with his head. In this way the vicious bull can exercise and is always fastened.

Through the use of these facilities all the mature bulls can be kept in one building, whereas, heretofore, they were badly scattered about.

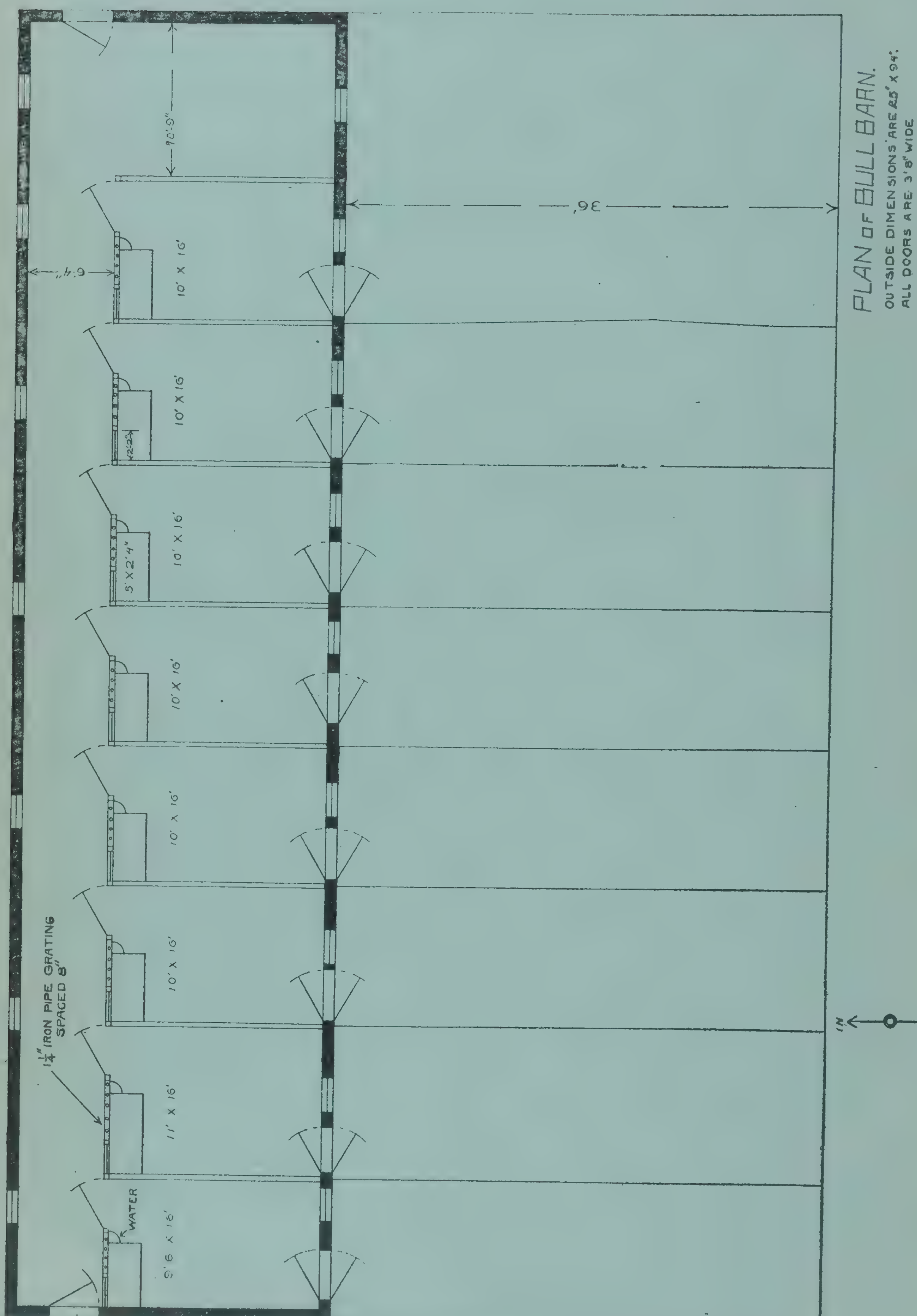
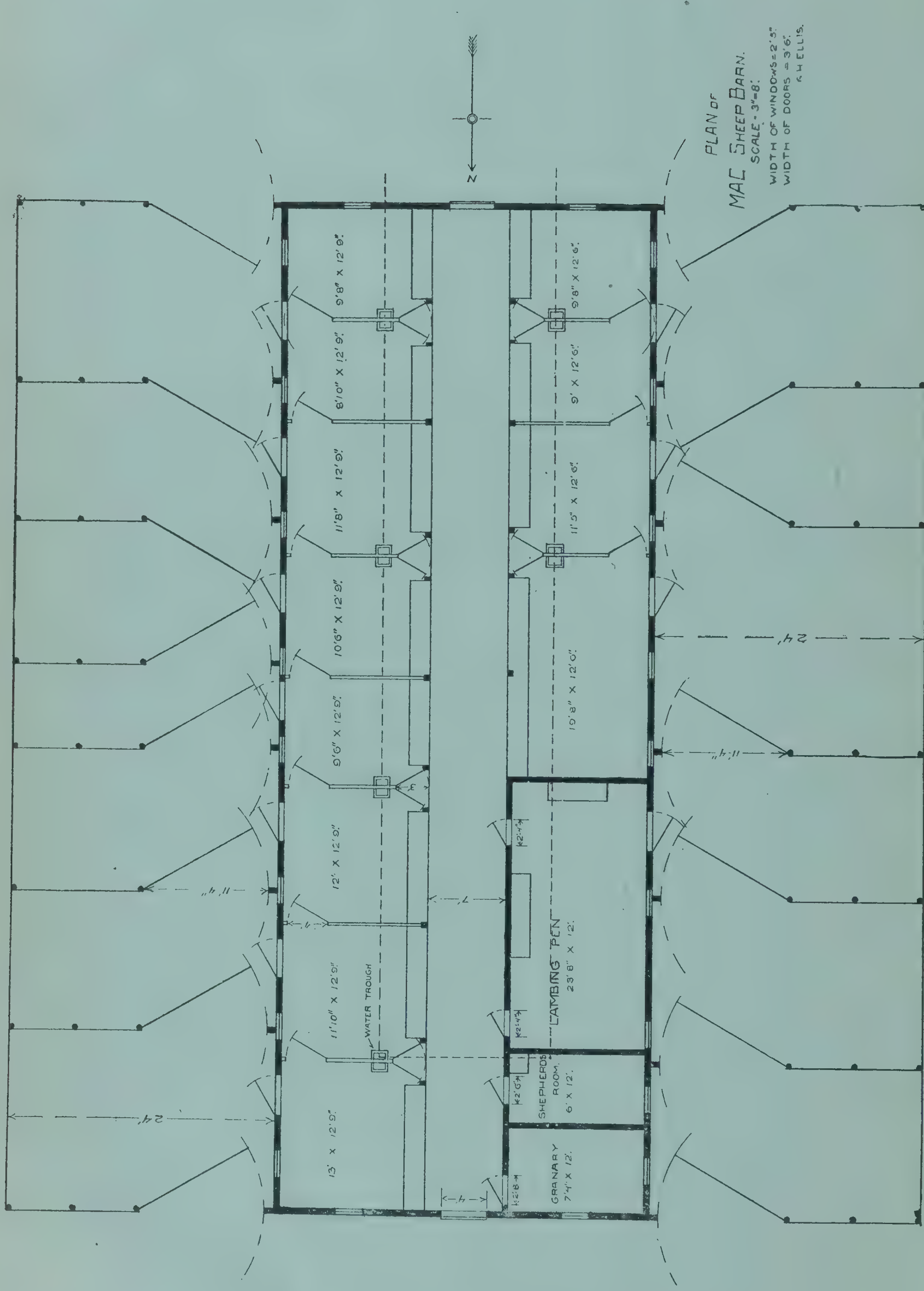

PLAN OF BULL BARN.
OUTSIDE DIMENSIONS ARE 25' X 94'.
ALL DOORS ARE 3'8" WIDE
1¼" IRON PIPE GRATING SPACED 8"
WATER
36'
10'9"
6'4"
10' X 16'
10' X 16'
10' X 16'
10' X 16'
10' X 16'
10' X 16'
11' X 16'
9'6" X 16'
5' X 2'4"
N

Fig. 31.

SHEEP BARN.

Figure 32 shows a portion of the ground plan of the present sheep barn occupied by the pedigreed breeding flocks. The original location of this structure is shown in illustration Fig. 1. To the south end of this building an additional 60 feet of much the same plan has been added to accommodate the experimental flocks. One of the worst features of this building is its division into two parts by a seven foot alley running lengthwise throughout the center. In the first place, the alley is one if not two feet wider than is necessary, but this fault could not be corrected in the remodeling owing to the short length of joists overhead in the center of the building, forming joints over the old posts, thus preventing their removal. In the second place, there is a very decided objection to a sheep barn with pens on both sides of a central alley, because of the draughts that are sure to prevail. It is desirable to give the animals on both sides of the building access to the yards daily; if the pen doors on both sides are open at once there will nearly always be more or less draught, no matter how still the air may be and these influences are likely to result in prevalent colds and catarrh. Few sheep barns are so located that the pens can be opened up on one side or the other according to the direction of the wind, but if this arrangement cannot be made we would prefer a barn opening on one side only, to one with pens on both sides of a central alley.

According to the accompanying plans, this building is fitted with pens varying in size from 9 ft. x 12 ft. 6 in. to 12 ft. 6 in. x 9 ft. 8 in. Such a large number of divisions was necessary because of the special use to which this building is put, viz., that of housing eight different breeds of pedigreed sheep which must be kept separate except when on grass. This explains why the alley was put through the center. The space marked box stall is used as an early lambing pen and is not only boarded up on all sides but is lined as well. All outer doors, except at the ends of the main alley, are in two parts, an upper and a lower; the lower part is hinged to swing out and the upper part slides on rollers thus forming a very suitable combination to regulate the admittance of air and sunlight according to the conditions and the needs. A part of each partition, next the outer wall, consists of a four foot door which can be opened and fastened back against the partition when it is desired to throw two pens into one, or the whole of each side can be opened up if necessary. The doors opening from the alley into the pens are placed in a V shaped position at every other partition to avoid cutting up the feed racks and economize in space. The central alley, feed rooms and shepherd's room are floored with concrete; all the pen floors are earthen. The lighting of this building has been discussed heretofore in the general consideration of that subject. The sheep occupying this barn, and the new addition also, require from fifty to sixty buckets of water daily during the winter; we have devised a water system for the entire building which is now being installed. This system consists of a series of concrete basins with inside measurements at the top as


PLAN OF
MAC SHEEP BARN.
SCALE - 3"=8'.
WIDTH OF WINDOWS = 2'5".
WIDTH OF DOORS = 3'6".
R.H. ELLIS.
N
9'8" X 12'9"
8'0" X 12'9"
11'8" X 12'9"
10'6" X 12'9"
9'6" X 12'9"
12' X 12'9"
11'10" X 12'9"
13' X 12'9"
WATER TROUGH
9'8" X 12'6"
9' X 12'6"
11'5" X 12'6"
10'8" X 12'0"
LAMBING PEN
23'8" X 12'
SHEPHERDS ROOM.
6' X 12'
GRANARY
7'4" X 12'
24'
11'4"
7'
4'
3'

follows: Length fifteen inches, width nine inches, depth twelve inches; the bottom is smaller to allow the inside form to be removed; the thickness of the walls of these basins is about four inches. A basin is being placed under every other partition so that it can be used from two pens. The bottom of the partition is notched out to allow the top of the basin to come high enough above ground; the bottom of the basin will be imbeded far enough in the ground to prevent the connections with the main pipe from freezing. No valves will be used in the basins, so that the whole system may be drained out frequently by connection with a sewer from the down spouts.

STALLS, MANGERS, FLOORS, ETC.,

The market offers large numbers of patented stalls, mangers and devices for tying cows and other classes of cattle; but appliances of this class cannot be taken up for description or discussion in a publication of this kind. We appreciate the fact that there are strong arguments favoring metal stall fittings and doing away with as much of the wood used as possible, in order to secure good sanitary conditions. At the same time, however, there are many people unable to purchase expensive fittings who are able themselves to build those made of wood. In our remodeling and refitting work we endeavored to use home made appliances so far as possible, in order to give the farmer with limited means an opportunity to pattern from them and do his own construction work where such was necessary. There is no subject relating to which more questions are asked of us than those relating to descriptions and dimensions of stalls for cows. In general, it should be borne in mind that the width and length of any stall is largely dependent on the size of the animal and the kind of manger and tie used. In giving the following data we attempt, in part at least, to answer some of these questions.

Figure 33 shows two types of stalls used in our grade beef barn. We may state at the outset that for the purpose for which these were built, and for the class of animals used, they have given good satisfaction. The cross section showing stall No. 1 is taken from a row used for eleven grade Shorthorn cows, with an average weight of about 1,000 lbs., which suckle their calves. This row of stalls, 35 feet long, is built on a cement platform 8 feet 6 inches wide, raised above the level of the alley floors 3 inches at the front end and 2 inches at the rear, thus giving the stalls a slope of 1 inch toward the gutter; this fall seems sufficient. It is a common error to give stalls too much fall; we have seen horse stalls given as much as 4 inches slope; so much is not necessary and may be injurious to the animal. In general 2 inches in 10 feet should be the maximum fall for a stall of any kind.

It was the intention to make these stalls about 3 feet wide from center to center, but they vary from 3 feet to 3 feet 7 inches, owing to adjustments that had to be made because of posts standing on the manger line, but this proves to be an advantage, some cows being larger than others. In this case, the distance from the manger to the drop is 5 feet 2 inches, and is eminently satisfactory for the size of cows

using the stalls; with the exception of one cow with peculiar habits they keep perfectly clean. The distance from manger to drop for a 1,300 pound cow should be abount 5 feet 8 inches, and for a 700 pound cow about 4 feet 6 inches. The width for the larger cow should not be less than 3½ feet and for the smaller 2¾ to 3 feet would answer. The bottom of the manger consists of two 2x12 inch planks laid side by side on the cement floor. The back of the manger is built up by a 2x4 and 4x4 on the plank bottom, the former lying between the two to permit fastening the bottom of the swing stanchion in the 4x4. Where swing stanchions are used the back of the manger should not be more than 8 inches above the floor or it will interfere with the cow when lying down; this will give the manger a depth of six inches inside to hold the feed. If cows are inclined to throw their feed out, pieces of 2x6, slanted on one side and about two feet high,

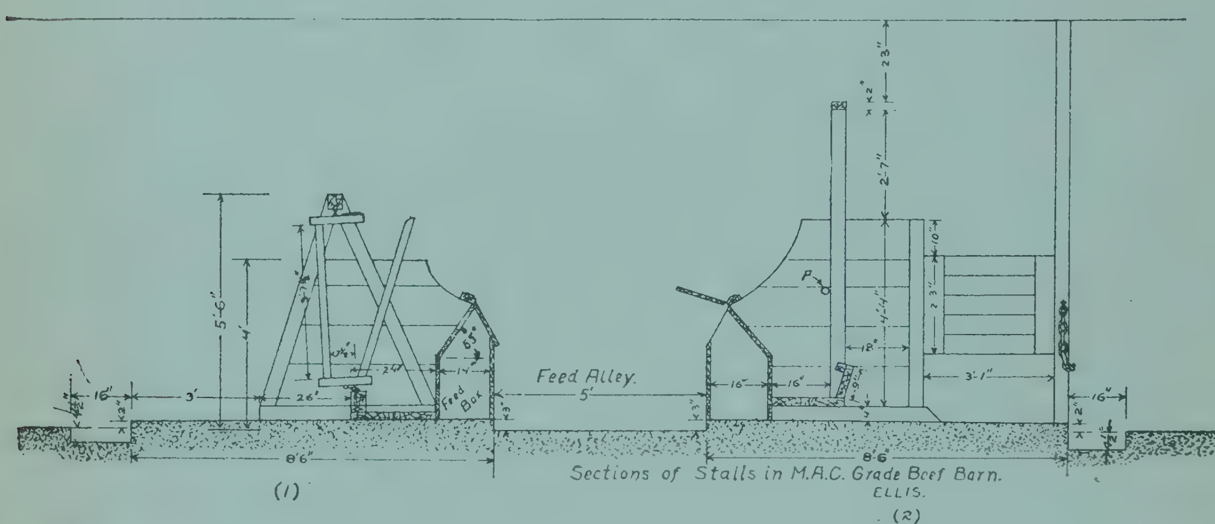


Fig. 33.

can be nailed to the front of the manger and side of the stall partition on both sides of the stanchion to prevent this. Some of the mangers of this type in use are 16, 18 and 20 inches wide on the bottom, inside measure; they should not be less than 18 inches. The front of the manger is perpendicular to a height of 18 inches when it slopes toward the feed alley to an angle of about 66 degrees for 18 inches more. This arrangement prevents the cattle from throwing roughage over into the alley with their noses as they can do if there is a continuous slope from the bottom upward and backward. The tie for this row of cattle consists of swing stanchions which are eminently satisfactory. The stall partitions which are built up 4 feet from the floor extend back toward the gutter from the manger but 26 inches to allow the calves greater freedom in suckling their dams; the partitions must be carried forward far enough and high enough to prevent the cows from reaching over. The partitions are all made of 2 inch stuff, the 4x4's underlying them are pinned to the floor by short pieces of gas pipe set into the cement and extending up an inch or two into the wood. Directly in front of this row of mangers is to be found a stationary row of feed boxes for meal. Each box is large enough to hold about two weeks feed for each cow, under ordinary feeding methods. This device origin-

ated from the necessity of keeping track of the food consumed by each animal under experiment. A certain amount of meal is weighed in at stated intervals and the feeder gives it to the animal according to her requirements instead of by weight, at each feeding. In this way the feeder will watch the animal more closely and at the same time the data is secured with much less labor. While these feed boxes are an experimental necessity they are not absolutely necessary for the ordinary farmer but we would be strongly inclined to use them for the herd operated on a commercial basis if an account was being kept with each cow, if not they could be fed from a car or carrier. Such an arrangement of feed boxes would be in the way, only, in installing some kinds of watering devices. Let it be remembered that the style of stall just described was designed for 1,000 pound cows suckling their calves; this plan would also answer for cows being milked.

The gutters in most of our recently remodeled stables are about 6½ inches high on the stall side, 4½ inches on the opposite side and 16 inches wide at the bottom, with one-half inch fall from one end to the other. There is much difference of opinion as to what the best dimensions are for gutters. We know of one barn fitted with shallow gutters two feet wide, and another with gutters not more than fifteen inches wide and a foot deep arranged in both cases so as to hold the manure over Sunday or during very stormy days without cleaning. Those with the dimensions heretofore given are furnishing very satisfactory results. One mistake universally made is that of giving gutters too much fall from one end to the other in order to flush them out. When this is done the urine all runs to one end and the absorbant used in the gutter is not efficient throughout its entire length. We have not given more than one-half inch fall to the gutters thirty-five feet long in the grade beef herd barn.

STALLS FOR DAIRY COWS.

Figure 33 No. 2 represents stall and manger fixtures devised especially for the use of dairy cows and so far as the partition and chain fastener at the rear are concerned they resemble the Bidwell type of stall. In this case, the stalls are constructed on a raised cement platform the same as described in Fig. 33 No. (1). The cow is not fastened at the head or neck, but is confined in the stall, loose, by a chain behind.

The manger bottoms are raised four inches above the floor resting on the 4x4's used for bed pieces for the partitions. The mangers are 16 inches wide, inside, on the bottom with back side 9 inches high and sloping somewhat toward the stall with 2x2 inch strip along inside at top to prevent waste of feed; the front part of manger is constructed according to description given in (1) Fig. 33. Owing to the fact that the animals confined in these stalls are not tied the partitions were made 4 feet 4 inches high, four inches higher than for the ones already described.

There are two special features about this stall, one is the iron pipe shown at P, in the illustration, which runs through all the stall

partitions at a point four inches back from the rear of the manger and thirty-five inches above the cement floor. This pipe keeps the cow from moving forward intó the manger and dropping manure on the stall platform. The proper adjustment of this pipe is very important to the comfort of the cow as well as the efficiency of the stall. If properly placed the cow cannot move too far forward and can stand at ease with the head above the pipe or eat comfortably with the head below it. A second important feature is the swinging or gate like portion of the partition. Such hinged partitions have been used to allow the cow to turn slightly and leave the stall without backing out,

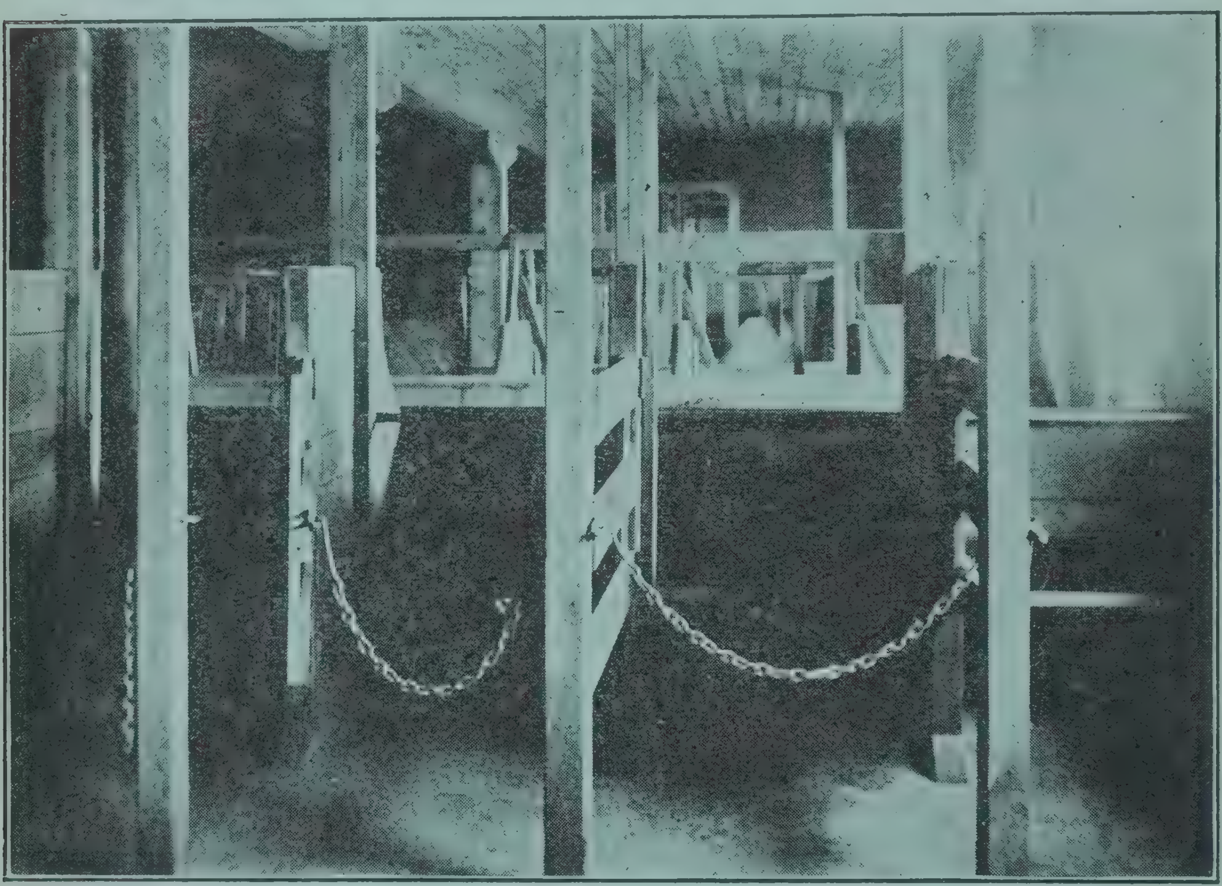


Fig. 34.

but these are too short for that purpose. They are intended to open partly at milking time to give the milker more room than the single stall affords and protect him from the movement of the animal in the adjacent stall. There is a piece of chain extending from post to post at the back of each stall. At one end the chain is attached to the post by a bolt running through the same with an eye on one end into which the chain link is welded and a thread and nut on the other end; at the other end of the chain there is a hook. The gate has a hasp fastener with a loop turned on the end of the hasp. When the cow is shut in the stall the hook is placed in the staple extending through the eye of the hasp. When the cow is to be milked the hook on chain of adjacent stall is removed to the loop in the end of the hasp, when the gate swings open allowing the milker to enter the stall, but preventing the cow from backing out, see Fig. 34.

Care must be exercised with stalls of this kind where the cow is not fastened at the head, that they are not made too wide. Stalls three feet from center to center are about right for 1,000 pound cows; if they are made six inches wider than this there is danger of the cow turning in the stall by swinging her head around under the gate partition. These stalls are 5 feet 3 inches from manger to drop and about the same adjustment as to length and width of stall, for larger or smaller cows, will apply as in the case of the stall shown in (1) Fig. 33.

STALLS FOR BEEF OR DAIRY COWS.

Figure 35 shows a stall, in duplicate, built to accommodate the cows of our pure bred beef herd, animals varying in weight from 1,000 to 1,600 pounds. In general, these cows suckle their calves, but sometimes

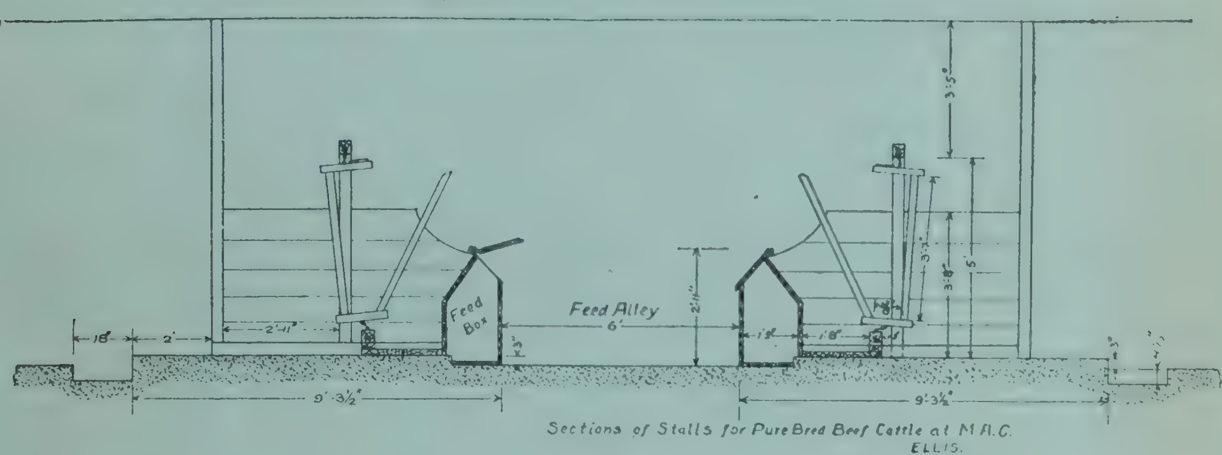


Fig. 35.

they are milked. For animals of this size with strong, lusty calves suckling them, a plain, strong stall was needed. The construction is identical with that of (1) Fig. 33, except for the partition and the general dimensions. The partition is built back squarely about two-thirds the distance from the manger to the gutter. This brings the upright oak 4x4, which is guttered slightly to receive the ends of the partition planks, back just in front of the cows hook or hip points. By giving these stalls a width of 3 feet 6 inches or even 4 feet from center to center, in a few instances, calves can readily suckle the large cows or they can be milked as desired. The present fastening is a swing stanchion; heretofore this class of cattle was fastened by chains around the neck, with a ring sliding on an iron bar bolted to the partition on one side of the stall. By the old system of tying it was more difficult to fasten the animal which could move forward and back and was not held so nicely in place as by the swing stanchion.

A number of other kinds of stall divisions, mangers and ties in use are not as satisfactory as those heretofore described. On the west side of the dairy barn—see Fig. 28—there is a row of mangers much like that shown in (2) Fig. 33, but differing in that the cow is fastened around the neck by a tie attached to a chain running across the stall and bolted to the partition on both sides; this is not as con-

venient a form of tie as the swing stanchion and the cow is allowed too much freedom to move back and forth, standing too much of the time in the gutter. The stall partitions, in this group, consist of swinging frames made of gas pipe threaded and screwed together at the junction points; these frame like gates cannot be kept tight at the joints, hinges or fasteners. On the opposite side of this barn there is a row of mangers fitted for swing stanchions, but with very short stall divisions extending back only two feet from the bottom of the manger and sloping up toward the stanchion at the top. These short partitions do not prevent the cows from crowding each other or moving sideways away from the milker, thus causing difficulties. The manger in this row of stalls is only three inches high above the manger bottom at the back, and feed is easily thrown out by the cows. Stall dimensions etc., were also commented on in individual descriptions of the stables.

CALF STANCHIONS AND MANGERS.

Figure 36 is intended to illustrate what we now consider to be the best form of combined stanchion and manger in use at M. A. C. for calf feeding. The principle of the stanchion is not new; its use dates back a number of decades, but the especial application and adjustment of the one hereafter described presents some new features. This particular model is produced as the result of three years' trial, having undergone several changes since the first one was installed. This appliance can be adjusted so as to accommodate the calf from birth up to twelve months of age. The calves are confined in the stanchions at feeding time only. After the calf has been secured the milk bucket is placed in the manger; when the milk is consumed the bucket is removed and ensilage and meal supplied, followed by hay. If individual records are being secured the calf remains fastened until the roughage is all consumed, but if not it is freed when the latter is supplied. By using this stanchion method of feeding the maximum number of calves can be kept in a minimum amount of space in a clean, healthy, thrifty condition, providing they are given access to outdoor yardage. The average size of the four calf pens in the dairy barn, including manger space, is 15 feet three inches by 12 feet 3 inches. Each pen accommodates eight calves up to five or six months of age. The average size of two pens in the grade herd barn, accommodating six calves each, is 9 feet 9 inches by 14 feet 10 inches, and three pens occupied by five each are 10½ feet by 11 feet 9 inches. Of course, in all cases except one the calves have access to yardage at will.

Referring again to figure 36 for detailed description, the bottom of the manger, 18 inches wide, consisting of 2 inch hemlock, is 6 inches above the floor. As the front of the manger is built on rather than against the bottom it leaves the inside bottom measurement of the manger 16 inches. The side of the manger over which the calf's neck is placed in feeding is 8 inches above the bottom, one-half of this distance being taken up by a 2x4, the balance by the bottom framework of the stanchion resting on it. The top part of the manger over which the calf feeds is

15 inches above the floor and should not be made higher, as even this is rather high for the new born calf. The youngest calves can feed over this, but should not be left fastened during the day, as they could not lie down comfortably. The side of the manger next the feed alley is practically 2 feet high and 2½ feet above the floor; the slope given to this part of the manger is a very decided advantage, especially in placing and removing buckets while the calf is fastened in the stanchion; even more slope than that indicated would be well. The manger is partitioned off every two feet; this should be the minimum width, for while it is ample room for the young calves, even more room would be desirable for the roughage of the older ones. The manger partitions extend upward as far as the curved line shown in the illustration, but this is the most

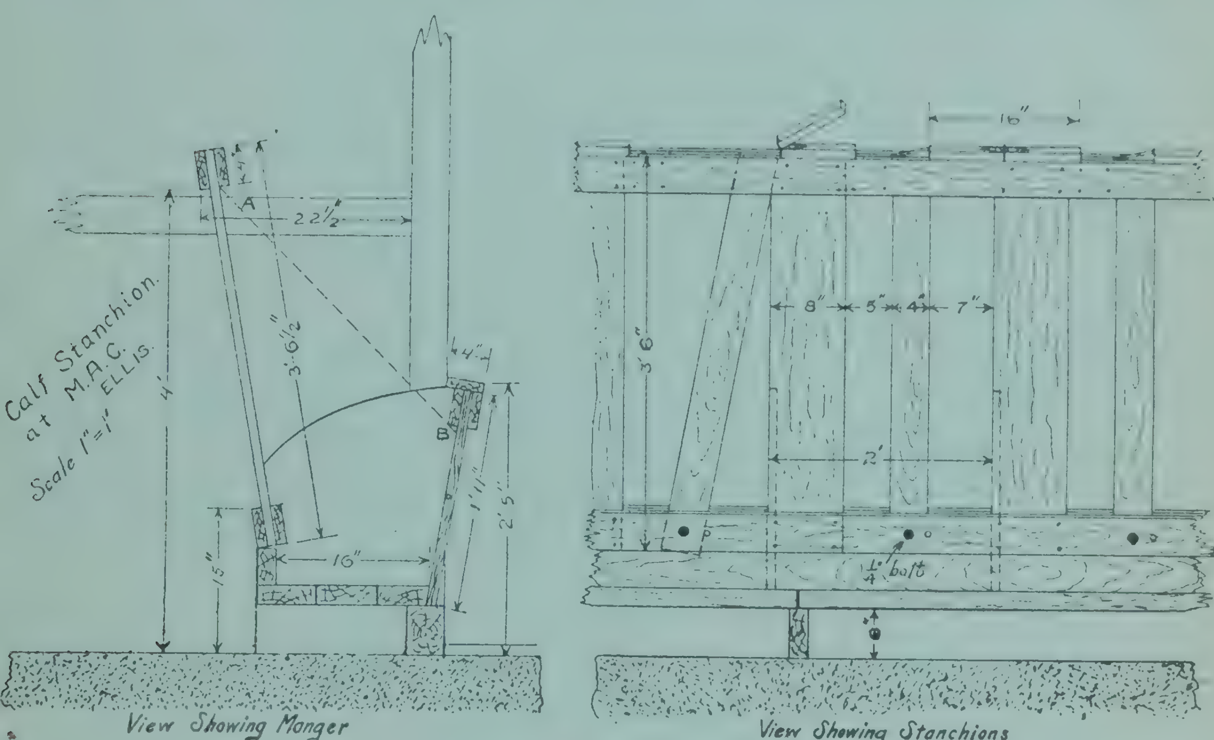


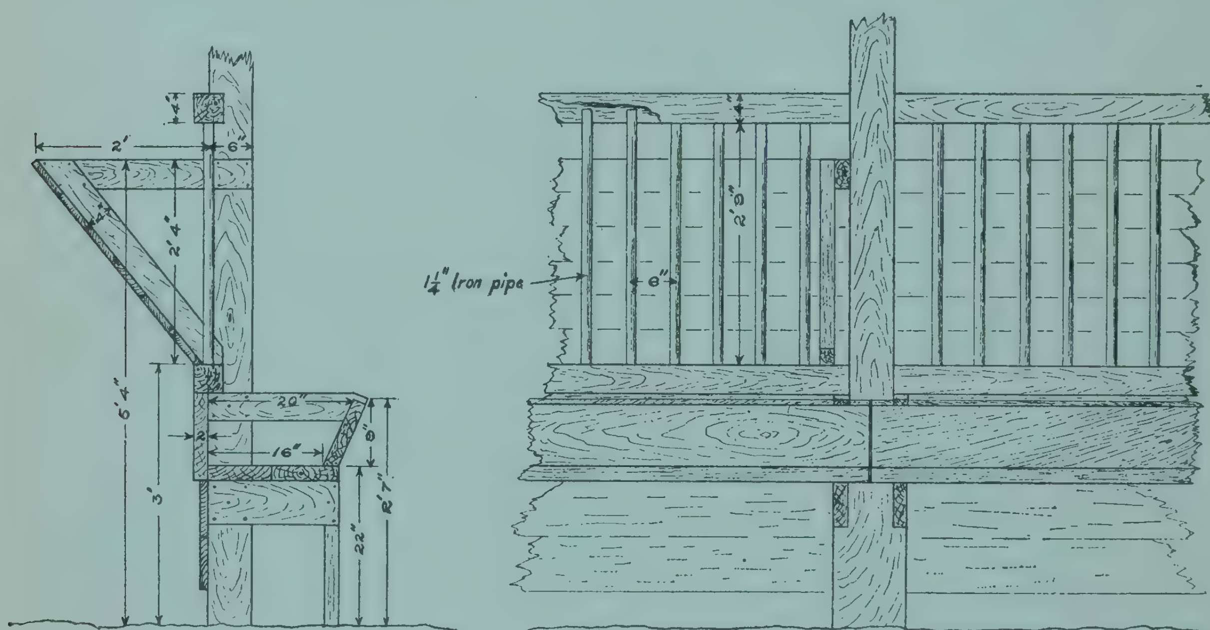
Fig. 36.

faulty feature of the fixture, as it is possible for one calf to reach over and suck another one's ears if the meal and ensilage is not promptly supplied after the milk is consumed, though this rarely happens. A more perfect manger division, which we propose to install, will be made by boarding up from the manger to the dotted line shown between A B. The front or stanchion part of the fixture is 3 feet 6½ inches high and slopes away from the manger to increase its capacity and give the calf the benefit of a little more spread in throwing the head up to remove it from the open stanchion. The stanchions are made of well seasoned 1 inch elm and no breaks have occurred thus far. The youngest calves do not require more than five inches space for the neck when confined. The stanchion frames are bored with a number of holes so that the movable upright pieces can be shifted according to the size of the calf. As calves approach the yearling stage and their horns interfere with the working of the stanchion the movable piece may be removed and the animal allowed to go free while feeding. This system has given us the utmost satisfaction, permitting calves to be fed individually according to

their needs and entirely preventing the many bad habits so frequently acquired by the pail fed calf. Very young calves, under three weeks of age, may acquire the sucking habit despite this device if placed in a box stall with other calves before they have learned to take meal.

RACK AND MANGER FOR SHED FEEDING.

Except where experimental work is in progress and individual records are desired, it is very often more satisfactory to feed groups of animals loose rather than in individual stalls. This method is particularly appli-



FEED RACK
— FOR —
BABY BEEVES
scale 1"=1'
H.H.M.

Fig. 37.

cable to the wintering of young heifers and stockers, and also to the fattening of baby beeves, and even more mature steers. In Fig. 28 an "enclosed exercising shed" is shown on the extreme south end of the large dairy barn; this used to be the old beef cattle barn. During the past winter the over crowding of cattle forced us to equip a part of this exercising shed to finish a bunch of ten baby beef cattle from weights of about 700 to 1,000 pounds. A part of the shed at the end next silo, 24x24 feet, was partitioned off on two sides by yard fencing, a feed rack enclosed the third side and the end of the barn the fourth. Alleys were left on both sides of this feed yard for the passage of cattle from the main barn to the shed.

When it came to building the feed manger and rack we found it took considerable time in figuring and trying out, to get them exactly right for the purpose intended, hence we furnish a sketch of the equipment as shown in Figure 37.

The manger, which is built of 2 inch material, is sixteen inches wide on

the bottom, twenty inches at the top and nine inches deep inside measurement. The bottom of manger is 22 inches above the ground and the top 2 feet 7 inches; the rack for roughage, which projects into the alley, rests on the back of the manger; it is 2 feet 4 inches high, and 2 feet wide at the top. The front part of the feed rack through which the roughage is drawn, is 2 feet 9 inches high, and is made of 1¼ inch gas pipe, 6 inches apart from centre to centre, embedded about 2 inches in 4x4's at bottom and top. The piping was secured at little cost from the ruins of a building destroyed by fire; of course, it would be rather too expensive to purchase new pipe for this purpose.

For the size of animals using this equipment, the character of the food fed, and the desire to avoid waste, it was eminently satisfactory. Clover, ensilage and meal were the foods used. There are many very decided advantages in favor of the farmer with a small bunch of cattle feeding them in this way.

WINDOWS FOR FARM BARNS.

Sunlight is one of the most important factors in the stable management of live stock, especially for young growing animals and breeding stocks. A generous supply of it is needed in the cow stable for the maintenance of proper sanitary conditions and the good health of the animals. Dairy barns are seldom furnished with sufficient light; in fact, in the great majority of cases it is sadly lacking. At present we can recall having seen but one barn, owned by a private party, provided with a superabundance of light. On the other hand, thousands of barns, especially of the basement type, have but few small windows, located close up against the ceiling, so that sunlight cannot reach but a very small area within the building, and that only near the centre.

The grade herd barn, which has been in use two years since it was remodeled, seems to be very satisfactorily lighted as regards amount and location of lights. The west elevation of this building, which runs north and south, is shown in Figure 38, the ground plan in Figure 29. The barn is fitted to house thirty-three head of mature cattle in stalls, and also twenty head of calves and young cattle, making a maximum capacity of fifty-three head, in addition to liberal alley and granary space. The building has 3,600 square feet of floor space and 145 square feet of window light surface, or 1 square foot of glass to every 24.8 square feet floor surface. It is interesting to note the relationship between glass area, size and shape of buildings, and amount of floor space in the various college barns. The grade dairy herd barn, 45x70 feet, with 3,150 square feet floor space, has 155.6 square feet glass, 1 foot to every 20.2 square feet floor space; though possessing more glass than the grade beef herd barn, it is not so well lighted, owing to the high, narrow, double windows with studs and casings between. The pure bred beef and dairy cattle barn, a T-shaped structure, the main part being 44x72 feet, and the annex 40x75 feet, with a combined floor area of 6,068 square feet has 373 square feet of glass, or 1 foot to every 16.2 square feet of floor; T-shaped stables are hard to light; the annex of this building

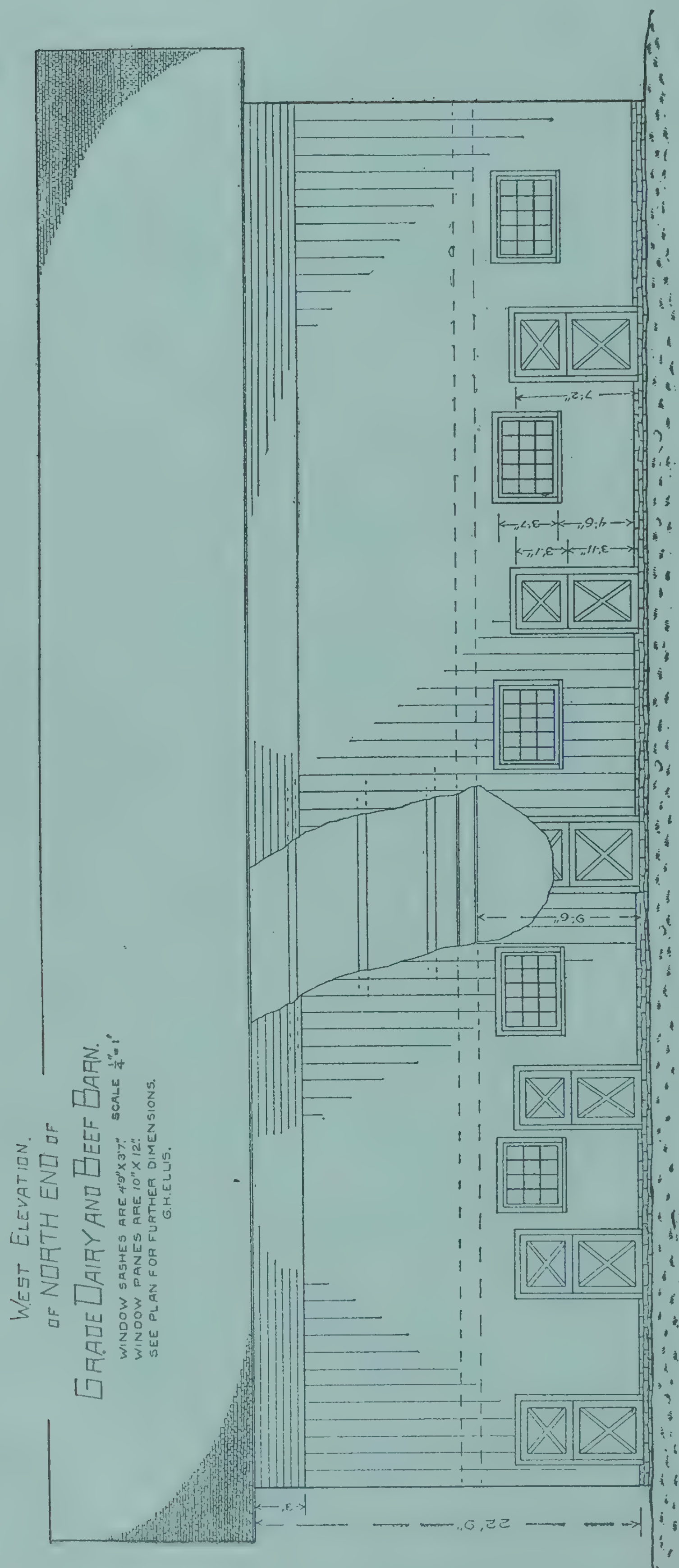

WEST ELEVATION.
OF NORTH END OF
GRADE DAIRY AND BEEF BARN.
SCALE 1/4"=1'
WINDOW SASHES ARE 4'9"X37".
WINDOW PANES ARE 10"X12".
SEE PLAN FOR FURTHER DIMENSIONS.
G.H.ELLIS.
22'9"
9'6"
7'2"

Fig. 38.

is well lighted, but the main part is not exceptionally so, despite the large amount of glass used. The new horse barn, 48x94 feet, with a floor area of 4,512 square feet, has 200 square feet of glass, or 1 foot to every 22.5 square feet floor space. The pure bred sheep barn, 34x90 feet, with a floor area of 3,060 square feet, has 105 square feet of glass, or 1 foot to every 29.1 square feet floor space; this building seems well enough lighted with its smaller glass area, but this may be because of its narrowness. The experimental sheep barn, 34x60 feet, with 2,040 square feet floor area and 45 square feet glass, or 1 foot to 45.3 feet floor space, is not well lighted. The piggery, 34x80 feet, with floor area of 2,720 square feet, has 119.5 square feet of glass, or 1 foot to every 22.7 square feet of floor. The farmer's barn heretofore referred to as being so exceptionally well lighted belongs to J. W. Hibbard, of Bennington, Mich. It is 58x62 feet, with 3,596 square feet floor area and 210 square feet of glass, or 1 foot to every 17.1 feet of floor space; on the other hand, however, we located a basement barn in this state 40x46 feet, with 1,840 square feet floor area, having only 15.7 square feet of glass, or 1 foot to every 117 feet of floor space; the windows of this barn were typical of the common basement equipment, each consisting of three 9x14 inch lights placed in the wall directly below the sill. From the foregoing data it would seem safe to conclude that as a general rule, a well lighted stable should have about 1 square foot of window light to every 20 to 25 square feet of floor surface, depending on the amount of glass that can be placed in south, east and west exposures.

Referring again to Figure 38, on the west side of this building there are four windows with sash measurements of 3 feet 7 inches by 4 feet 9 inches, each containing fifteen 10x12 inch lights, and also a fifth one 3 feet 7 inches by 3 feet 9 inches with twelve lights. These were distributed as evenly as possible without cutting posts and girts such as are numerously found in an old fashioned timber framed barn. Another window could not have been put in the space between the two doors at the north end without cutting a large bent post, but this difficulty was overcome by placing three twelve light windows in the north end. On the east side along which an eight foot alley runs the entire length of the barn, there are four fifteen light windows, the addition of one more would be desirable, but was prevented by the construction of two circular silos on that side of the barn. The south end of this building adjoins the grade herd barn.

The bottoms of the window sills are 4 feet 6 inches above the stall floor and the top of the casing is 15 inches below the ceiling. We consider the size and location of these windows very satisfactory, and favor them strongly because of the amount of light that they admit and because they are high enough from the ground outside and from the floor within to prevent breakage by cattle. Long narrow upright windows are not desirable; for instance, we found one dairy barn fitted with this sort, with casement measurements 4 feet 6 inches high and 2 feet wide, with upper and lower sash each containing four 10x12 inch lights; this style of window is too narrow to allow the light to spread and so low as to be subject to frequent breaks. Pairs of these windows, side by side, but separated by studding, are not so satisfactory as the single large fifteen light window heretofore described. The windows in the barn under discussion are pivoted in the center at the ends, with wooden stops so

placed on the casing that the lower half swings out and the upper in when open; this is eminently satisfactory in warm weather to admit a maximum amount of air, but is not so desirable in the winter, in that cold air enters the building at both bottom and top of window, instead of at top only. It also prevents covering the space occupied by the window with screens or cotton in summer. For winter use only it would be more desirable to have the windows hinged at the botton to swing in at the top. Windows either hinged or pivoted are subject to a greater amount of breakage than those in ordinary use. The windows in the granary at the north end of this barn are hinged at the top to swing in and hook to the ceiling thus permitting the unloading of grain and meal from the wagon directly to the bins.

We have several outside doors leading into the alleys of one or two barns with windows in the upper part or half. Stable doors containing glass are a source of much annoyance and loss, for every time a strong wind gives the door a hard slam some lights are sure to be broken; the necessary light should be secured elsewhere. Nothing but standard sized lights such as 8x10, 10x12, etc., should be used unless in very exceptional cases. To illustrate, we have found lights in one group of barns of such odd sizes as 9⅞x13 inches, 10¾x11½ inches, which means that in replacing special sized lights must be cut. In presenting this illustration of the lighting of our grade beef barn we do not intend the inference to be made that the sizes and placing of lights given is absolutely necessary, for satisfactory results can also be secured by modifying these according to the particular demand.

CEMENT FLOORS.

In the remodeling and refitting work cement floors have been constructed in all the stock barns, including horse barn and chicken houses, the only exceptions being the pens and box stalls of the sheep and bull barns. Despite the few objections urged against it, the use of concrete for stable floors and stalls is continually increasing. Some of the criticisms made against concrete floors are not well founded. Sometimes it is claimed they are too slippery and as a result animals fall and receive serious injury. It is true that this frequently happens, but it is due to improper construction; a floor given a smooth finish with a trowel is positively dangerous; it should be left to harden with a rough finish, such as that produced by the vigorous use of a steel broom. Alleys over which animals pass are rendered additionally dangerous by giving them more slope toward the gutters than is necessary. Strong claims have been made to the effect that concrete does not make a good stall bottom, producing rheumatism and other ills among dairy cows; this may be true if too little bedding is used and the animal is forced to lie on the concrete. Our experience with concrete floors dates back to 1888, and in no case can we recall a single instance where trouble arose from the use of these floors for cattle stalls when plenty of bedding was used. It is true, however, that less bedding is needed for stalls with wood floors. In many sections of the country it has become a common practice to overlay concrete floored stalls with boards or planks. It is doubtful

if the best sanitary conditions can be maintained in this way. In the new horse barn two stalls were planked over the concrete, experimentally, and a blindfolded person could detect them while passing down the alley, from the stench of the urine soaked wood. Those whom we know to have used concrete in horse stalls for three or four years in succession do not object to them.

Because the bed of the pig on a cement floor becomes damp and befouled so easily it is desirable to use overlays which can be removed regularly and thorouoghly cleaned during the winter season. Whatever its faults may or may not be the concrete floor permits of the maintenance of better sanitary conditions than any other that has yet been used. The question of sanitation in the old type of barn is a very important one; there are plenty of cow stables in use even yet where the urine and barnyard seepage will squirt up from between the planks as one walks over them. There are still a good many horse barns with the same old auger holes in the plank floor back of the stall to allow the urine to drain away beneath the barn. There are barns still with no floor at all except the earth with which the solid excrements and urine have been incorporating for years.

WATER SUPPLY FOR STOCK BARNS.

With the exception of the sheep and bull barns no attempt has been made to install equipment in the cattle barn to supply the animals with water in the stalls. There are two principal reasons why this has not been done. In the first place the adjustment of mangers and feed boxes, so as to secure individual feed records of such a large number of animals, has rendered the work of installing water systems somewhat difficult. But in the second place, a more important reason exists, viz., that we have been unable thus far to devise or secure an equipment that would seem to be satisfactory in every respect. All devices seem to work well when first installed, but many of them go into disuse in a very short time. When we can install a water system that gives promise of the maintenance of good sanitary conditions and durability as regards efficiency, then we propose installing the same. At the present time our cattle drink from concrete troughs placed in the yards. During the winter season tank heaters are used in these troughs.

EQUIPMENT OF SWINE DIVISION INCLUDING BUILDING, COTS, YARDS, FENCES, ETC.

The Building.—Fig. 39 represents the ground plan of the College piggery as it is now fitted for use. The building itself was among the first erected at the institution for housing live stock and was constructed almost solely by student labor. It is a very old building but, nevertheless, today it contains some excellent material in almost perfect state of preservation. The excellent pine siding and the oak posts,

studs, joists, rafters, sheating and lining, bespeak of days when these materials were plentiful and so inexpensive that nothing but the choicest was used even in the construction of a piggery. The quality and value of these materials, combined with the necessity for making the best use of the material at hand, were some of the conditions requiring the refitting of the old rather than the erection of a new building. In planning and constructing a new building there should be nothing to interfere with the development of the most perfectly desirable plans; in refitting an old building conditions are sure to arise to thwart the execution of desired plans or changes. It is also possible to figure very closely on the cost of erecting a new building while estimates on reconstruction, or refitting, seldom fail to fall short owing largely to the inability to determine exactly what material must be replaced, particularly that which is covered up.

We do not present these plans desiring our readers to accept them as models for the Michigan swine raiser, for the conditions at the College are very different from those surrounding the average breeder or pork producer. While few private individuals keep more than one breed of hogs, the College is maintaining no less than seven distinct breeds for a double purpose. The primary object in keeping so many breeds is to furnish plenty of good specimens to give our students an opportunity to study, in the most practical way, the breed type and characteristics of each breed; the secondary object is to furnish stocks of desirable types for experimental breeding and feeding purposes. The number of breeds enumerated, requiring the maintenance of several boars, and the numerous lots of experimental and breeding pigs, demands a structure with a large number of pens. The plan of the remodeled building and added equipment are therefore presented, not as models, but with the hope that here and there suggestions of value may be thrown out.

During the past few years there has been a marked increase in the advocacy and use of cots for sheltering swine during the entire year. On first thought our plans may seem to oppose this method but such is not the case. We are using all the pens in this building and also a dozen cots in yards during the entire year, the former for boars, young pigs and experimental feeders and the latter for brood sows and young animals being grown for breeders. Both methods have their merits and demerits, but we are becomming convinced that under Michigan conditions, with our rigorous winters, a combination of piggery and cots is more desirable for the swine grower than either alone.

The ground plan in Fig. 39 shows the form of the original building 34x80 feet, consisting of a main structure 24x80 feet with a lean-to 10x80 feet on the south side. Originally this building was fitted with a passageway 8 feet wide all the way across the north side. The remainder of the enclosed space was divided into ten pens of various widths extending from the passage way on the north to the south wall of the building. These long narrow divisions were divided in the center forming inner and outer pens; the former were used for feeding and sleeping quarters and the latter as sort of covered sheds. By this arrangement with the pens proper running down through the center of the building, there was no possibility of sunlight ever reaching the sleep-

ing apartments. According to the present plan the building is divided the long way through the center by an alley 6 feet wide, thus leaving 14 feet of pen space on each side which is an ideal length for pens. The pens on the north side of the building are used for boars and the

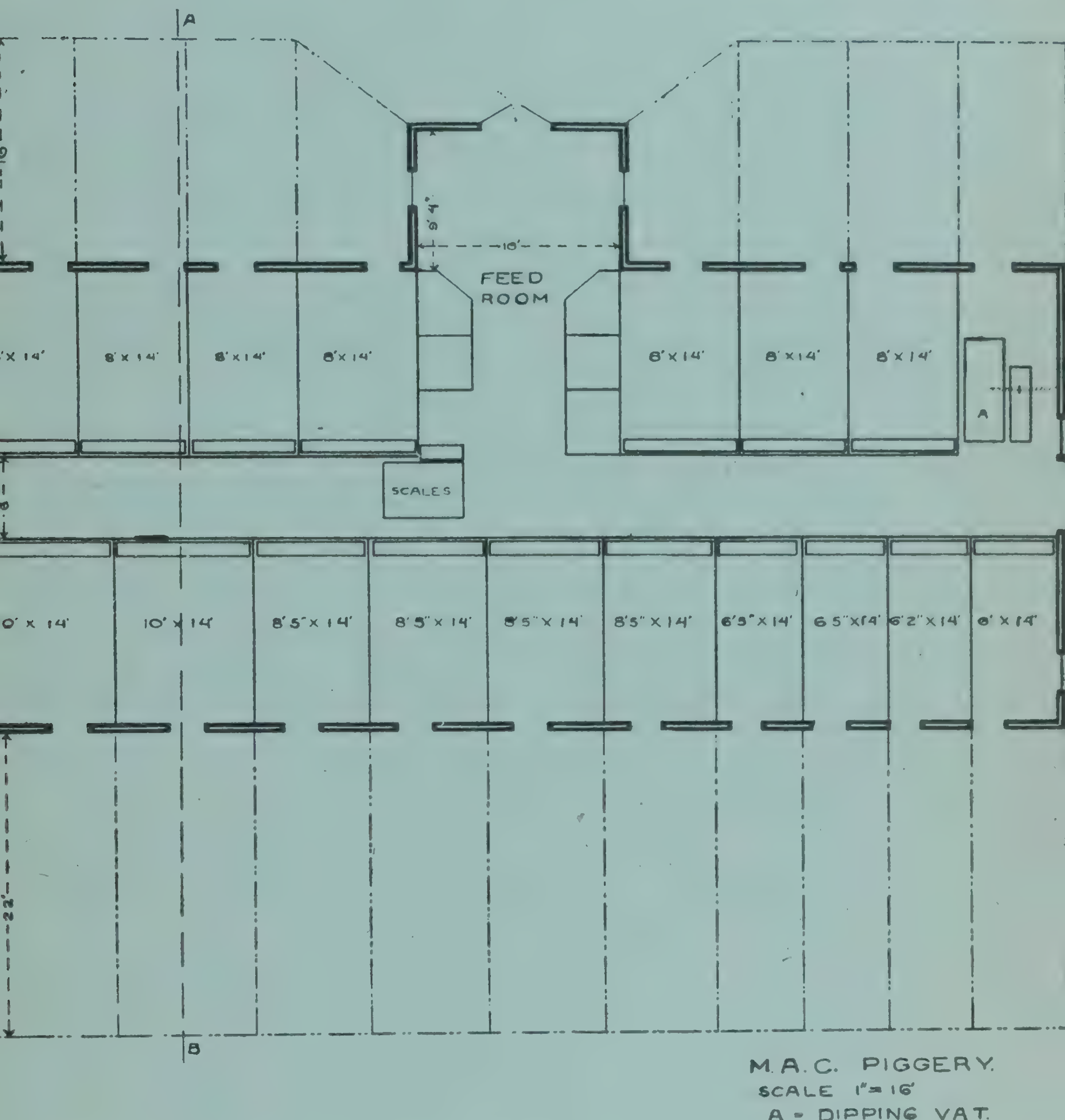


Fig. 39.

more mature feeder hogs, while those on the south, admitting an abundance of sunlight, are used by pigs, younger feeders, and to a limited extent by brood sows and their litters. Each pen has access to yardage enclosed with woven wire except the partitions between the boar yards which are constructed of boards; the outer ends of the boar pens are, however, enclosed with woven wire. The yards are the same width as the pens within and are 16 feet long on the north side of the building and 22 feet on the south side. A pair of platform scales is located in the alley at the feed room having been set down in the cement flush

with the floor; this is one of the most necessary and most used conveniences about the equipment. There are many who prefer that a piggery cut through the center by an alley with pens on both sides, should be placed on a north and south line in order to admit sunshine on one side in the forenoon and on the other in the afternoon. Many of the simplest, most useful and most inexpensive piggeries are long narrow buildings with but one row of pens; in the use of this form of piggery the pens should invariably face the south.

Cross Section and Piggery.—Fig 40 shows a cross section of the piggery at the section line indicated by A B in Fig. 39. The foundation, as shown by the illustration, consists of the stone wall originally placed under the building. Had it been necessary to replace this foundation, concrete would have been used, being easier to build and less costly. The piers on both sides of the alley supporting the posts, are constructed of concrete. The entire floor is made of concrete, and is four inches thick; the lower three inches consist of coarse gravel seven parts and cement one; the upper inch, or top-dressing, consists of sharp sand three parts and cement one. The alley running throughout the center of the building its entire length, is six feet wide; this width rather than being a waste of space, is one of the greatest conveniences about the building. An alley placed along one side of a long narrow building need not be so wide but should not be less than four and one-half feet in the clear. Feeding alleys are almost invariably made too narrow. The six-foot alley shown in the illustration is crowned over, being one-half inch higher in the center to insure its being kept perfectly dry, and was given a rough finish to prevent animals from slipping while being driven to and from the weigh scales. A rough finish can be given by brushing the cement lightly with a steel broom after it has been laid and troweled down. The floors of the pens were given a fall of two inches from the alley to the outer doors, but this is not as necessary as was first supposed, the urine being completely absorbed when the pens are cleaned and bedded as frequently as they should be. We consider some fall to the floors desirable but not more than has been given in this instance; the fall is necessary when the pens have to be flushed out and the whole house given a thorough cleaning and disinfection. Pen floors should also be given a rough finish.

The partitions are constructed of one and a quarter inch oak boards, the material used for similar purposes in the original fittings. The boards were cut into three foot lengths and placed in an upright position, the bottom ends resting on a two-by-four and the tops capped with similar material. The two-by-fours were not guttered to receive the ends of the upright boards as this would make it difficult to replace one should repairs be needed; the ends of the partition boards are held in place by inch strips nailed on the two-by-fours on both sides. When partition boards are placed on end with the wood fibre in a vertical position, hogs cannot gnaw them so easily as when they are placed in a horizontal position. The partitions are raised three inches above the cement floor to prevent them from rotting quickly and to permit of thorough disinfection and the maintenance of good sanitary conditions. The raised sill may become dry and can be disinfected, the one on the floor cannot. The objection to the raised sill is that pigs will work manure underneath it and care must be taken to remove this when the

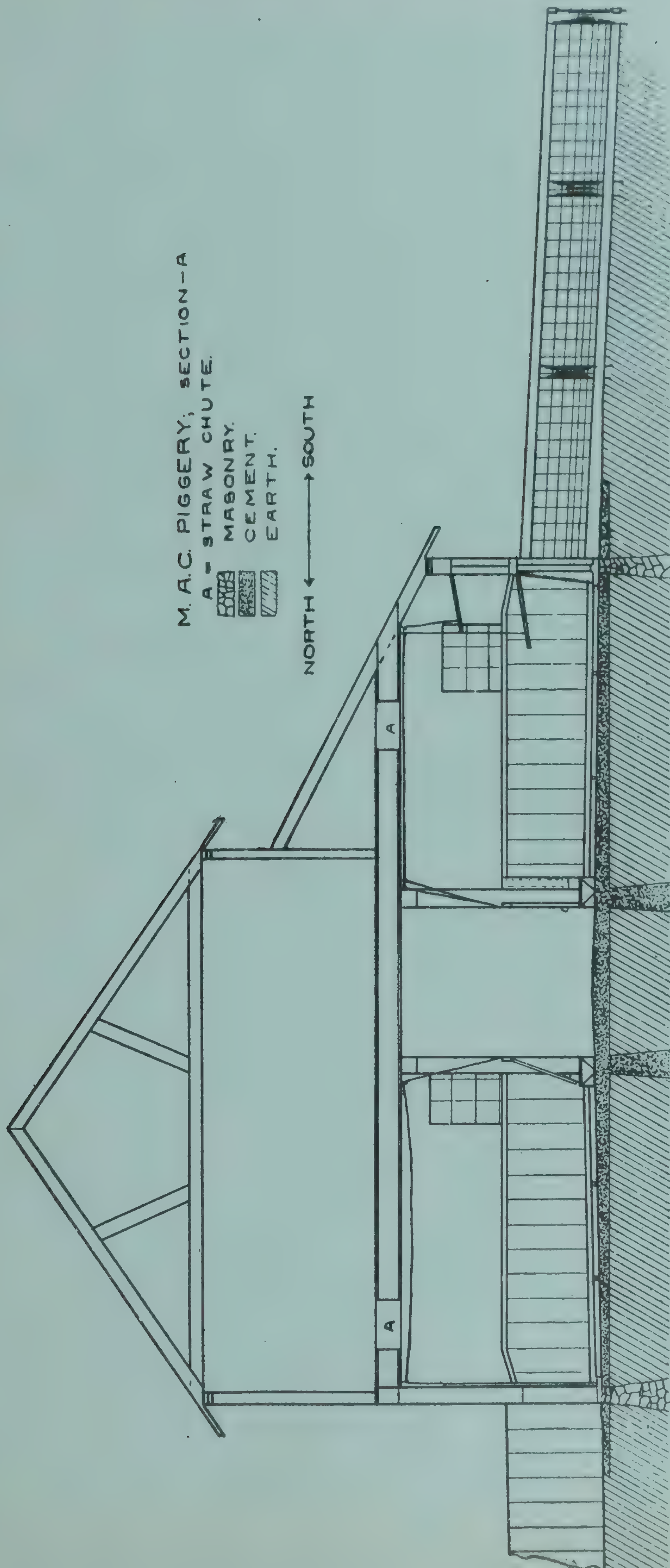

M. A.C. PIGGERY; SECTION—A
A = STRAW CHUTE.
MASONRY.
CEMENT.
EARTH.
NORTH ← → SOUTH
A
A

Fig. 40.

pens are cleaned. In order to prevent manure from accumulating under these sills, we are planning to fill this space with concrete by first tacking a board on one side and then filling the space with concrete held tightly in place by a board tacked on the other side until dry. We feel sure that this will remain in place and can be done much more easily than at the time of the floor construction. The two-by-fours forming the partition sills are fastened to posts at each end and are supported between by two pieces of gas pipe set in the cement and resting in holes bored in the wood of the two-by-four above. The top of the partition need not be more than three feet six inches above the floor. With the possible exception of the boar, a hog that requires higher fencing than this is an undesirable one to have.

The yards on the north side of the building where the boars are kept during a part of the season, are separated by board fences, this being the only safe material for the divisions between them; the ends of these pens are, however, enclosed with woven wire. On the south side the pens are constructed of woven wire, the method of construction being fully described later in this publication. For all yard pens a fall of a little more than a foot was established in the twenty-two feet in length, giving most excellent results. The possibilities for securing a good fall in every direction from the piggery should be one of the most important factors in determining its location. Wallows in pig yards, containing the drainings from the manure pile, putrid water and other filth, are prolific breeders and distributors of disease. The yards on both sides of this building have been covered with concrete floors. This is serving an excellent purpose in preventing the hogs from rooting holes and forming wallows against the foundations, and elsewhere. The breeding hogs of course spend most of their time in the larger yards and not on the cement pavement, but the paved yards will always be accessible for all classes of hogs at times when the other yards are too muddy to use.

The loft above is about eight feet high at the posts and furnishes an abundance of room for storage of straw, crates, crate materials, overlays, troughs, etc. No meal feed is stored in the loft. In general food stuffs stored in piggery lofts are continually exposed to extremely impure, foul smelling air.

In this piggery there is an average of one door, one window, and one trap above, for each pen. The traps above are seldom shut and the doors are sufficiently loose to swing. With all these openings we have not yet found an insufficient circulation of air.

This illustration also shows the ropes and pulleys by which both doors and ventilators are opened and closed from the central alley, there being no doors opening into the pens from the alley. The openings A A from the loft show how the bedding is supplied to the pens.

The Pens and Their Fittings.—Reference to Fig. 39 shows the pens to vary from six to ten feet in width. It also shows that the doors opening into the yards are not all regularly located either in the center or corners of the pens. This is due to the fact that the original openings were utilized and could not be readjusted without completely reconstructing the south side of the building. The doors of all pig pens should be located in one corner; there are two reasons for this, in the first place, if placed in the corner most remote from the direction of the

prevailing wind, greater protection is afforded the pigs in the pen when the door is open, and, second, it allows the proper construction of overlays.

Overlays.—What they are and the necessity for their use leads to a short, but necessary, discussion of flooring materials. The plank floor which has been so universally used in the past for piggeries, has now become almost impracticable owing to the scarcity of such material and its high cost; the use of hard wood is entirely out of the question and pine floors are short lived. It is almost impossible to construct a wood floor so as to make it water tight and provide good sanitary conditions. Dry earth floors would be ideal for the sleeping quarters for pigs if they could be kept dry and clean. At the present time there is no floor in use in piggeries more desirable or inexpensive, considering durability, than one properly constructed of concrete nor can as good sanitary conditions be maintained by the use of any other. And yet, notwithstanding these good qualities, cement floors are strongly objected to, and justly so too, on the ground that pigs become crippled if required to nest in beds on them during the winter season. Even though an abundance of bedding is used on cement floors, bad results seem to follow just the same. There are few worse places for a brood sow to farrow than on a cement floor. She gathers the small amount of bedding allowed her into a small pile, beds on it and the newly born pigs wriggle off on the bare floor, which being slippery, prevents them from getting on their feet, the cold floor soon exhausts them, and they perish. It was with the object of overcoming these objections to the cement floors that overlays were used.

Figures 41 and 42 show two pens, each ten by fourteen feet but with two different forms of overlay. Fig 41 shows an overlay running across the center of the pen; this form was used because of the outer door being in the center of the pen, thus leaving insufficient room for the overlay in the corner. This overlay is in two sections, each two and one-half feet wide so that it can be lifted easily in cleaning out the pen or thrown out in the sun to dry, or put in the loft for storage during the summer. The two sections are held in place by four blocks tacked on the two-by-fours at the bottom of the partitions. This arrangement leaves plenty of room for feeding at the trough and space for the manure near the door. The greatest objection to this form of overlay is that because of its location between the trough and door, the pigs have to cross it frequently, thus not only soiling it but dragging the bed off on the floor as well. This objection is sufficient to urge strongly against this form of overlay. Fig. 42 shows an overlay 6x8 feet in one corner of a pen with the door in the opposite corner. This plan is possessed of the advantages of providing more shelter for the bed when the outer door is open and the pigs can go in and out without crossing the bed. The accompanying illustration Fig. 43 shows nine 180-pound pigs bedded down comfortably on this overlay. This latter form of overlay is hinged to the wall so that when the pen is cleaned out it is tipped up, bedding and all, and any filth which may have accumulated underneath is cleaned out. When the floor is cleaned, the overlay is let down and the bedding thrown off on the floor for absorbent being replaced by fresh straw at least once a week. When the overlay is placed in the corner of the pen, that portion of the floor should be raised somewhat.

Both forms of overlay now in use in the piggery, were constructed from second hand inch lumber; they are raised off the floor by inch cleats which hold the boards together. A two-by-four was set up around the outer edges of the overlay to hold the bedding in place. (A two-by-six may be used.) These were nailed to the boards below and

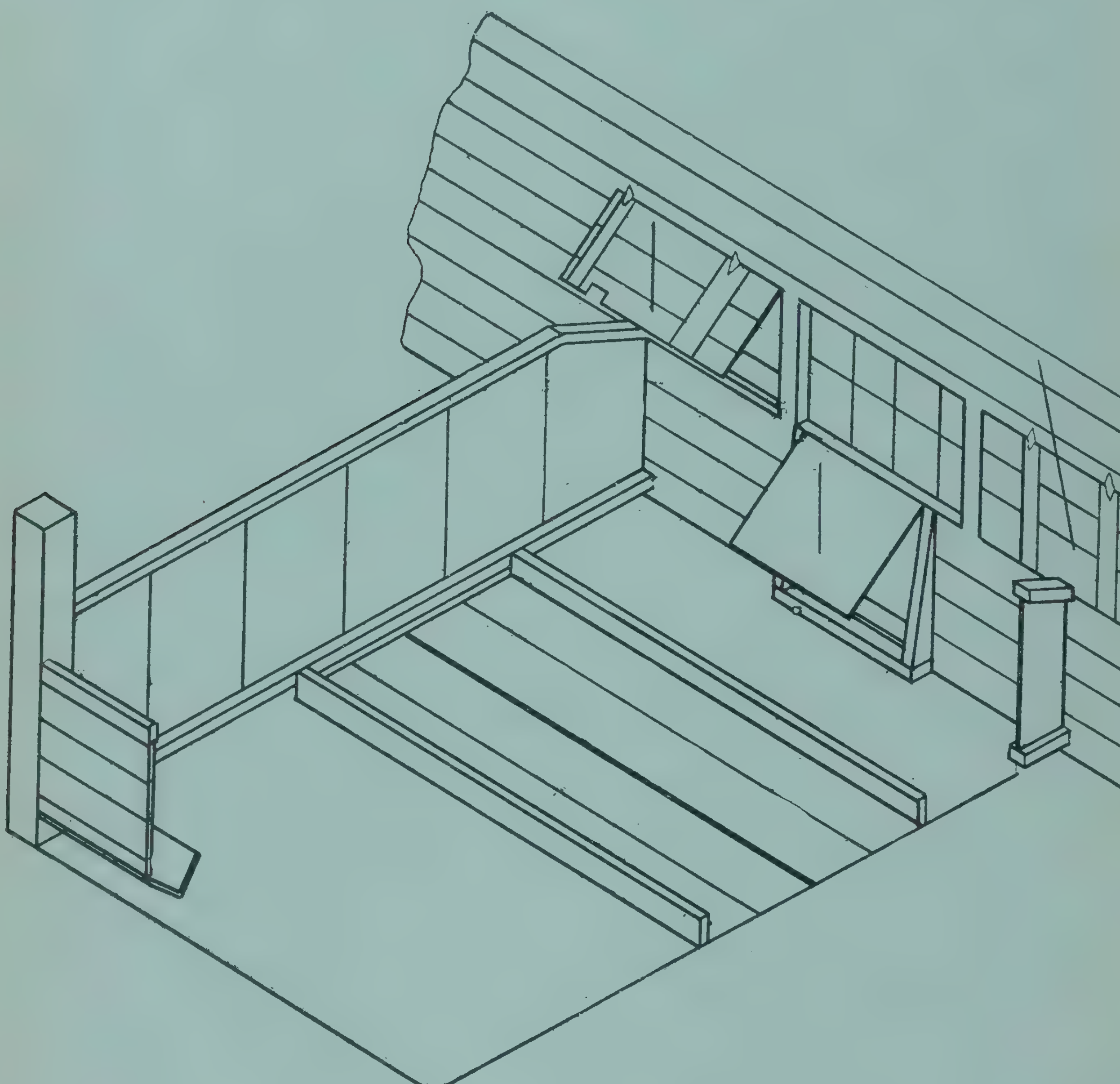


Fig. 41.

strengthened by triangular pieces of scantling fastened in the angle formed by the two-by-four and the board floor. In the use of these overlays three facts have been strikingly noticeable, viz.: First, pigs invariably use the overlays, by preference, sleeping on the bare boards if there should be no straw on them; second, of the three or four hundred hogs that have been housed in this piggery there are few instances where the bedding on the overlays has been befouled by excreta and the tendency to this is much less in the case of the overlays in the pen corners where the pigs are not trampling over them; third, we have not

had a crippled hog in the piggery since these devices have been in use. We dislike the plan of boarding or planking over the entire cement floor surface of a pen during the winter even for farrowing, as dung and urine work in between and under the boards or planks, producing very unsanitary conditions.

Figures 41 and 42 also show one of the two forms of doors used in the piggery. These doors swing inward from the top and are opened from

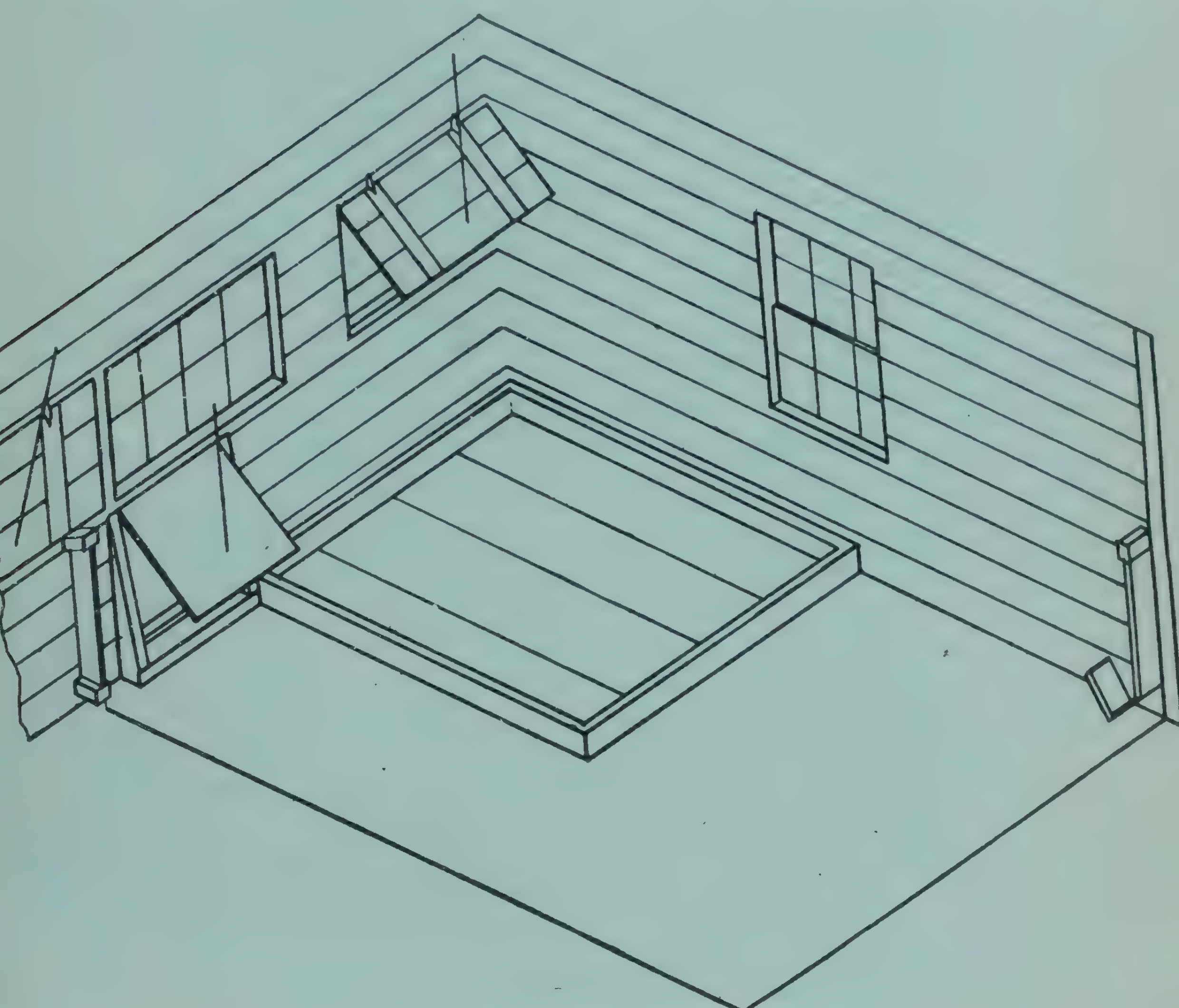


Fig. 42.

the central alley by a small rope operating over two pulleys as shown in Fig. 40. A light steel rod shaped door spring, fastened to the casing and top of door, forces it shut. Both the door casing and sill are widened by a two-by-six inch boxing which prevents the pigs from getting their noses under the bottom or side of the door to get out. A pig can come in but cannot get out if the door is closed. The only objection to this form of door is that an extremely severe southerly gale pushes them open a little and lets in too much cold; this is prevented by the use of small bolts for emergency cases. On the north side of the building the doors were constructed to slide up and down, but these could not be used on the south side without shutting off some light, the windows being directly over the doors. In addition to a door, each pen on the south side has a window above it and also a

hinged panel to one side of the window which may be opened in suitabl weather to admit additional sunshine and fresh air.

Troughs.—Figure 44 shows the feeding troughs with swinging partition suspended over them in such a way that when swung back the pigs are shut away from the troughs while the feed is being supplied, and when swung forward again in place, they have access to them. This is no

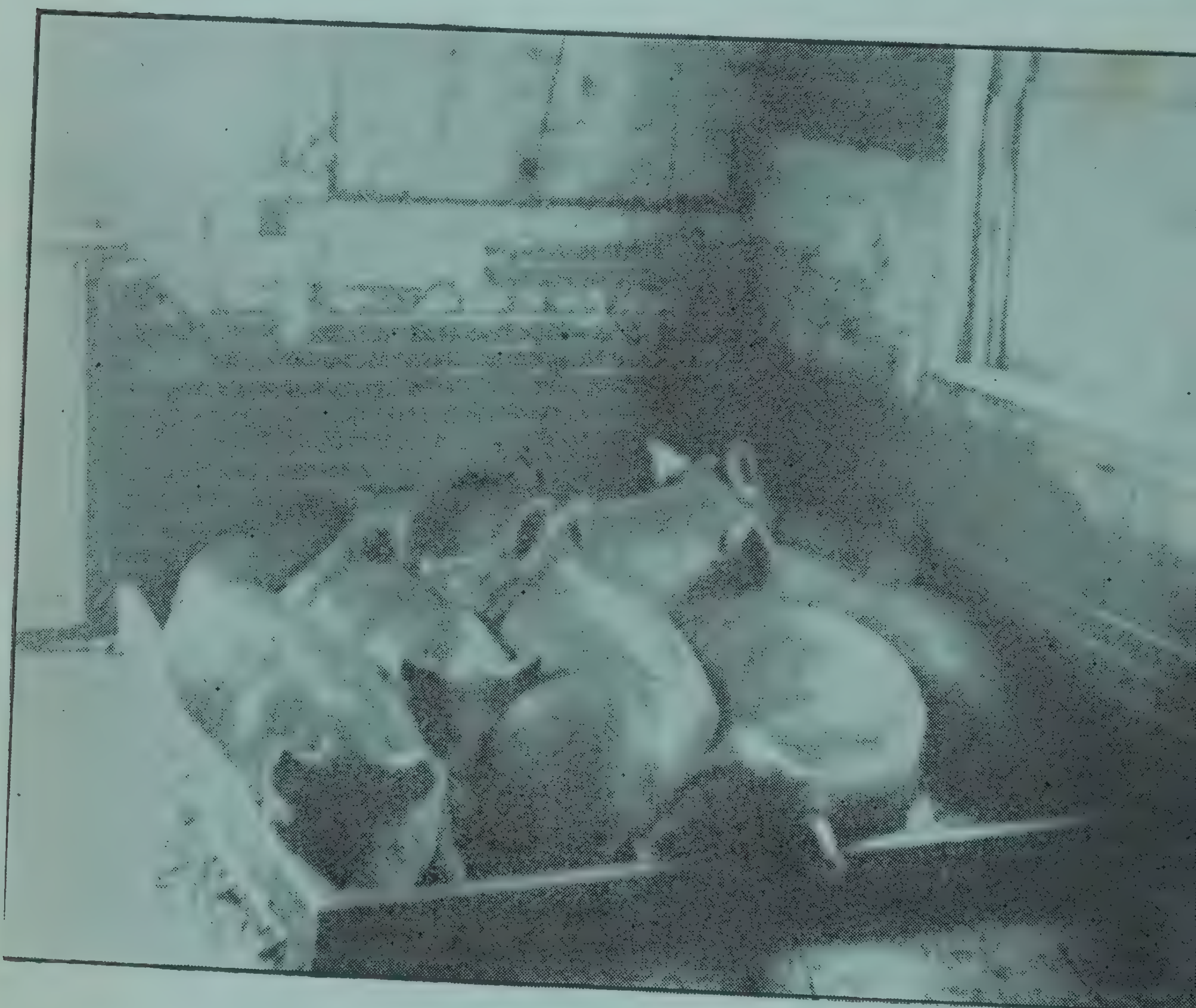


Fig. 43.

new invention for the device, with many modifications, is used in numerous farmers' piggeries. The only wonder is that it is not more universally used. The top of this swinging partition consists of a two-by-four from which the three-foot partition made of inch boards swings by hinges. This partition is held in place at all times by a half-inch iron rod which slips up and down in staples, being received at the bottom in holes bored in a hardwood cleat nailed across the center of the trough. This fastening prevents the pigs from moving the partition at any time. If the pens are over ten feet in width the swinging partitions are too cumbersome to work well. They should not be made to swing into the pen past the edge of the trough when fastened, or the pigs will soon gnaw the edge of the bottom board off. These partitions are made to swing back until they stand straight up overhead, resting at the ends between the

posts. This permits pigs to be driven out or in, or the cleaning of the pens from the alley. In this case doors connecting the alley and pens were purposely omitted.

The troughs are made of two-inch hemlock constructed in a V shape, one side being two-by-ten inch material and the other side and ends two-by-eight. These troughs are simply toe-nailed in between the division posts so that they can be removed easily and replaced when necessary. We like the V shaped troughs in preference to any flat bottomed sort, in the piggery, because the pigs can clean them more readily and thoroughly and there is practically no contact at the floor except for the short end pieces; as a result filth and moisture do not accumulate beneath them. On the under side of the V shaped trough, next the alley, the floor is always dry and on the pen side it can be cleaned thoroughly and is always exposed to the air. Hemlock troughs last from two to five years, or even longer, particularly if protected by a strip of band iron on the inner edge. Sloppy feed does not chill or freeze in wood troughs as readily as in cement or metal.

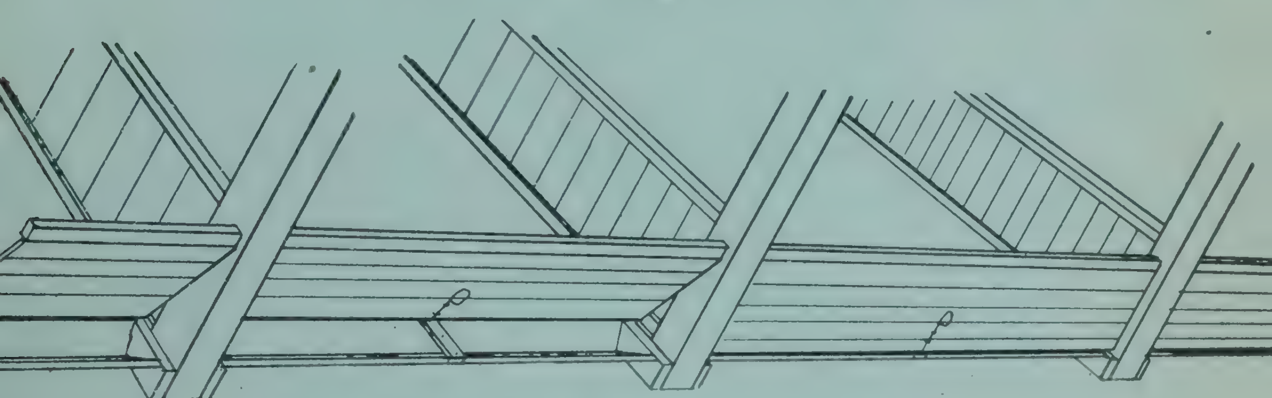


Fig. 44.

We like flat bottomed troughs for out door feeding where they are moved about frequently, they are not upset so readily as the V shaped ones. We also like low sided, flat bottomed troughs for weanling pigs.

Hog Cots.—Reference has already been made to the desirability of hog cots to use in connection with the piggery. When climatic conditions are not too rigorous, cots only are employed for handling the entire herd. In general, the climatic conditions in Michigan are too extreme to permit the use of cots for all classes of hogs for all purposes during the entire year. They are especially desirable, however, for dry brood sows and young males and females being reared for breeding purposes; it is in this way we are using them. They are desirable because an abundance of fresh air, sunshine and exercise are provided. During the summer season cotting and yarding nearly all classes of pigs cannot be excelled.

Figures 45, 46 and 47 represent three forms of cots now in use at the Michigan Agricultural College. Figs. 45 and 46 are forms which have been in use at the institution for some years. The form of cot shown by Fig. 45 is desirable in that it is warm in winter but objectionable in that it provides little protection against the extreme heat of summer. It is also considered a good form of cot for the brood sow to farrow in in moderate weather as she cannot lie down close enough to the

sloping roof to crush her pigs as against a wall. A general mistake is made in fastening this form of cot permanently to the skids, or runners, on which it is built. These are the first to decay and along with them the lower ends of the boards, thus making repairs impossible even though the balance of the structure remains sound. A separate pair of skids should be constructed for this or any other form of cot so that they can be replaced. Its own weight will hold the cot in place on the skids while being moved.

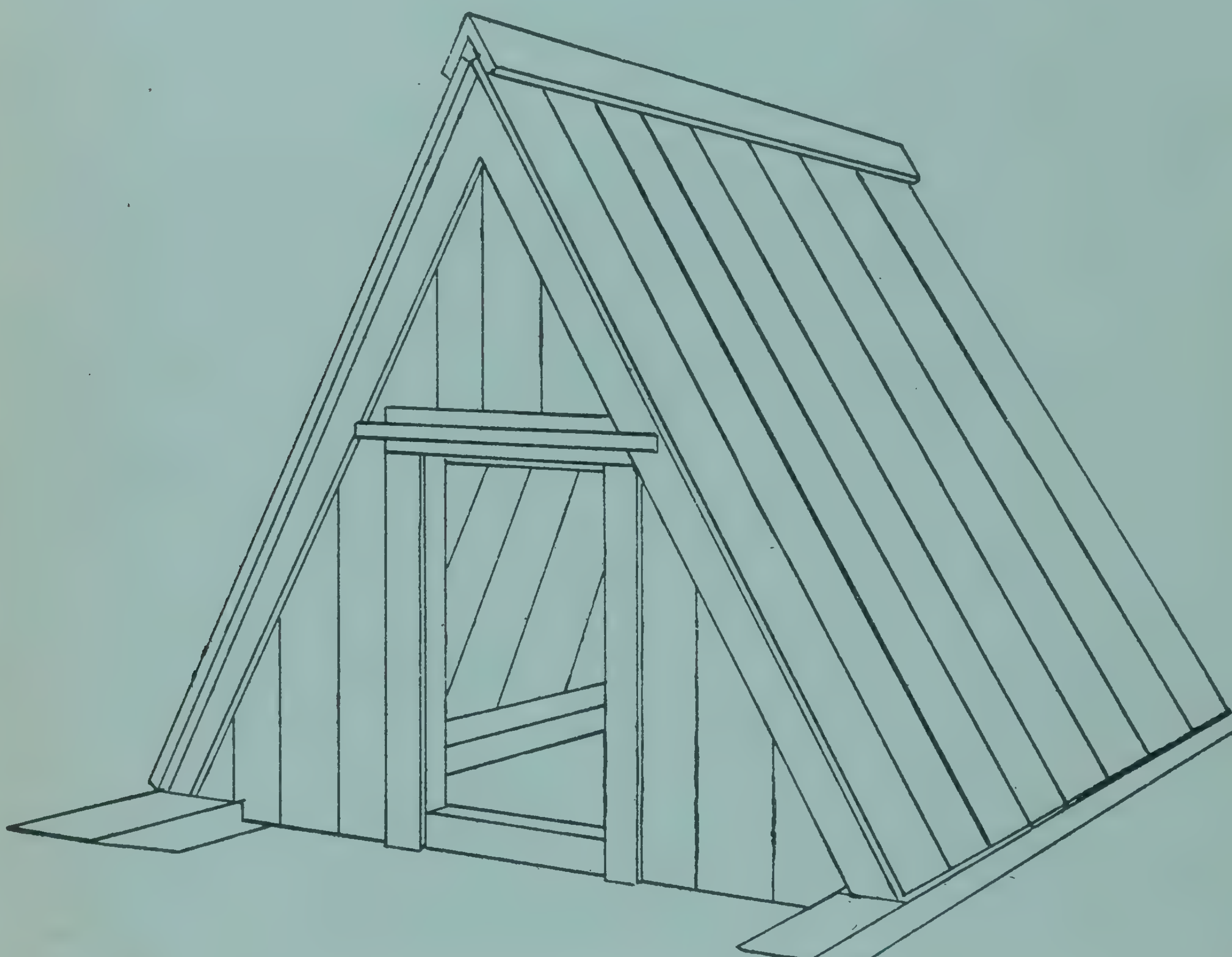


Fig. 45.

Fig. 46 shows a form of hog cot, six by eight feet, with perpendicular sides and a flat though slightly sloping roof. This form of cot is made in five separate pieces, the four sides and top, so constructed as to bolt together at the four corners. This form of cot is warm in winter and too warm in summer with its flat top exposed to the sun's rays, and though it may be planned so that the top can be raised in summer, there is trouble from the wind occasionally unroofing it. It is also objectionable in that the sections are too heavy for one man to move and as a result it is not moved as frequently as hog cots should be. All cots should be furnished with skids so that they can be moved frequently by a team and one man and not taken to pieces and moved in sections.

Figure 47 represents a form of cot recently designed and constructed and now in use in our hog lots. It is six by eight feet at the foundation

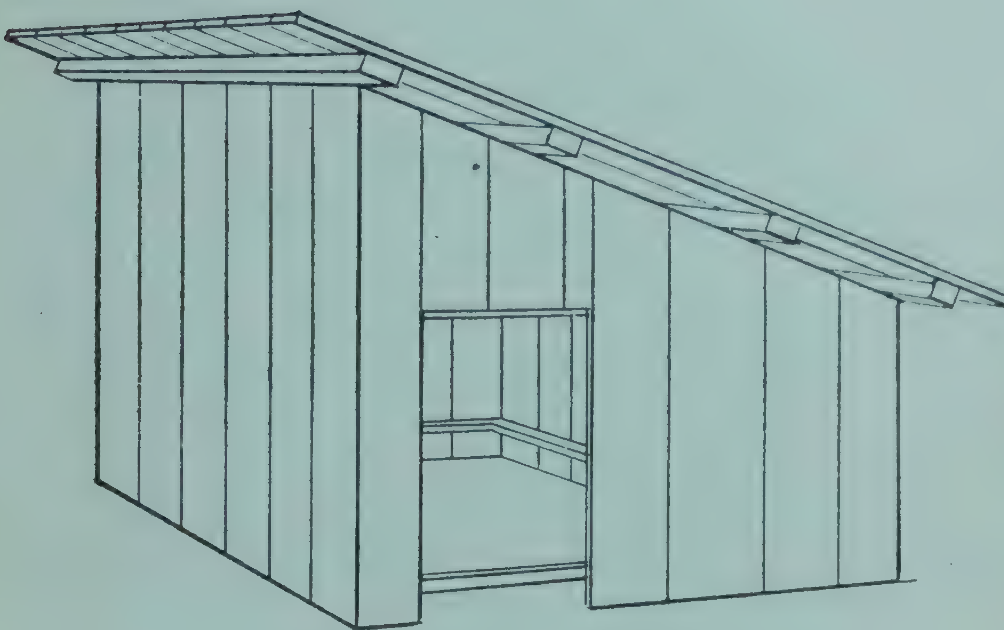


Fig. 46.

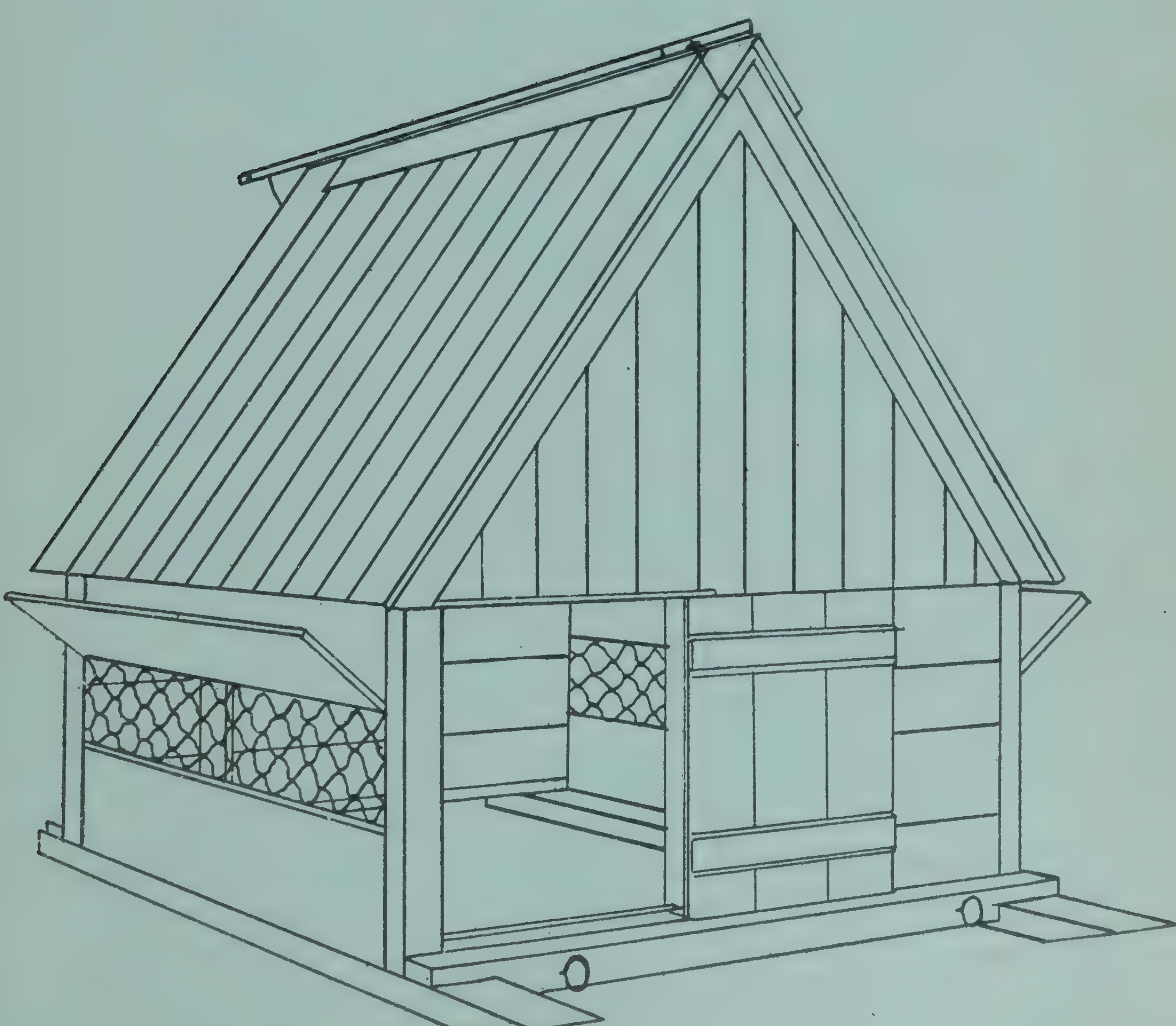


Fig. 47.

with the sides raised perpendicularly three feet before receiving the half pitch roof boards. The center boards on the sides are hinged so that they can be swung open in hot weather; the opening thus made is covered with strong woven wire, clamped above and below between inch boards; the inner clamp boards project an inch beyond the outer ones, thus breaking the joints and preventing any draught when the openings are closed. The two ridge boards are also hinged so that they can be opened during hot weather. These openings permit a free circulation of air which not only lowers the temperature but greatly relieves the oppression of the pigs seeking shelter. These openings close down tightly, leaving warm quarters during the coldest weather. The cots proper are supported on skids to which they are not attached, being held in place by the blocking of the ties across both ends. A two-inch bottom is used or not, as desired; this flooring is cut in lengths to fit crosswise and rest on the skids which are wider than the sills. This form of cot is not desirable for the farrowing sow without the addition of a railing around the perpendicular walls a few inches from the floor to prevent her from overlaying her pigs. Probably the chief objection to this structure is the expense of material and cost of construction. It contains 160 feet stock lumber, 60 feet matched, 20 feet four-by-six, 12 feet four-by-four, and 44 feet two-by-four and required two days' labor in construction.

Yard Fences.—The question of cheap, durable, and serviceable fencing for the small yards adjacent to the piggery is an important problem. During the past, lumber in various forms has been converted into fences of different styles for this purpose, but now its scarcity and high price renders its use almost prohibitive. A tight board fence probably makes the most perfect one for turning hogs. We have attempted to make a suitable substitute, in large part, for the lumber except in the case of the divisions between the boar-pens. The fences forming our small pens are constructed of woven wire with two-by-six inch material at bottom and top. The plan is shown in Fig. 48. Cedar posts are placed, in this case, a little less than eight feet apart. (They should not be more than this distance for pen fences.) The posts were notched out at the bottom and top one inch deep the width of the two-by-six. Thus, the two-by-sixes when firmly spiked in place, instead of being flush, projected an inch out from the surface of the post. The 26-inch woven wire was placed on the posts with top and bottom wires just touching the two-by-sixes. The woven wire was not stapled to the end posts but each strand brought around the post and wrapped on itself. The wire fencing was also stapled to the intermediate cedar posts and the top and bottom wires to the two-by sixes against which they rested.

The woven wire used was special hog fence with seven lateral wires, top and bottom wires No. 9 and intermediate No. 12. There are twenty-eight No. 11 cross wires to the rod. The woven wire and two-by-sixes make the fence thirty-eight inches high. This has furnished a cheap fence, and after several seasons' use we are satisfied with it. It is necessary to have the cross or upright wires spaced 6 or 7 inches apart in order to confine the smaller pigs which go through the wider spaces slipping the wires. But one repair has been made and that at a point where a flaw occurred in the wire. The openings of these pens consist of doors which slide up and down in grooves at the sides, dropping into slots at the bottom to prevent pigs from opening them.

Lot Fencing.—The term lot is here used to designate larger enclosures, such as those furnishing pasture and forage crops. In pursuing economic methods of swine husbandry, pasture and forage crops are essential throughout the greatest possible portion of the year. Few crops

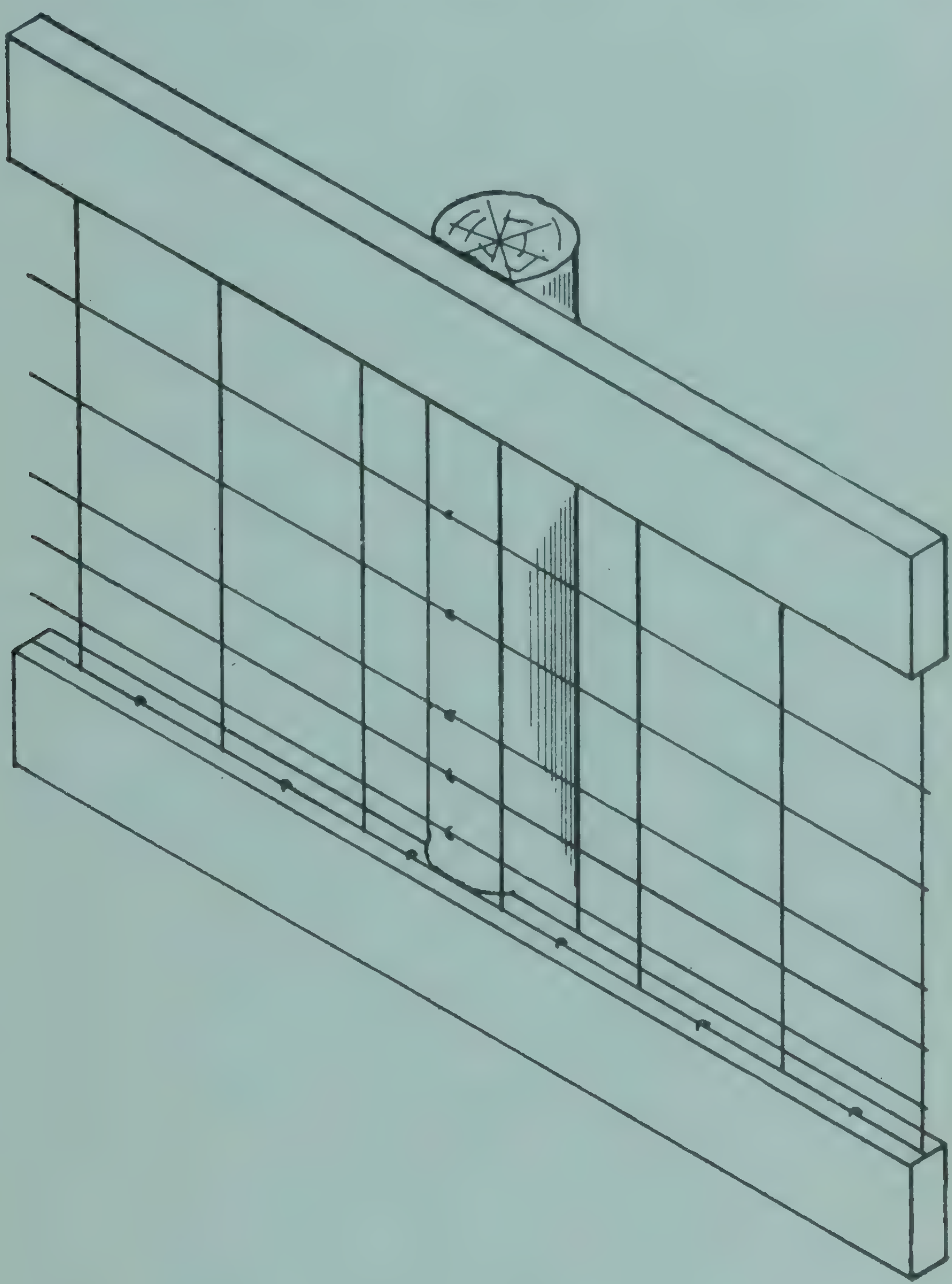


Fig. 48.

provide continuous pasturage throughout the growing season and even those which do may require resting spells for recuperation. Continuous pasturing and foraging by hogs is largely dependent on a succession of these two classes of crops. As a small area can be made to produce sufficient green crop for large numbers of hogs, this fact, in addition to the two already stated would seem to require either a number of small lots or one large one subdivided by portable fences or hurdles. Portable fences constructed of light lumber have been commonly used in the past but this material is no longer practicable under general conditions. If the

number of hogs on a farm will justify the growing of say six acres of forage crops, this should be enclosed and divided through the center by permanent fences. Division of the two halves can then be made by means of a portable woven wire fence as follows: Set a row of posts two rods apart across each half for the support of the portable fence; owing to the

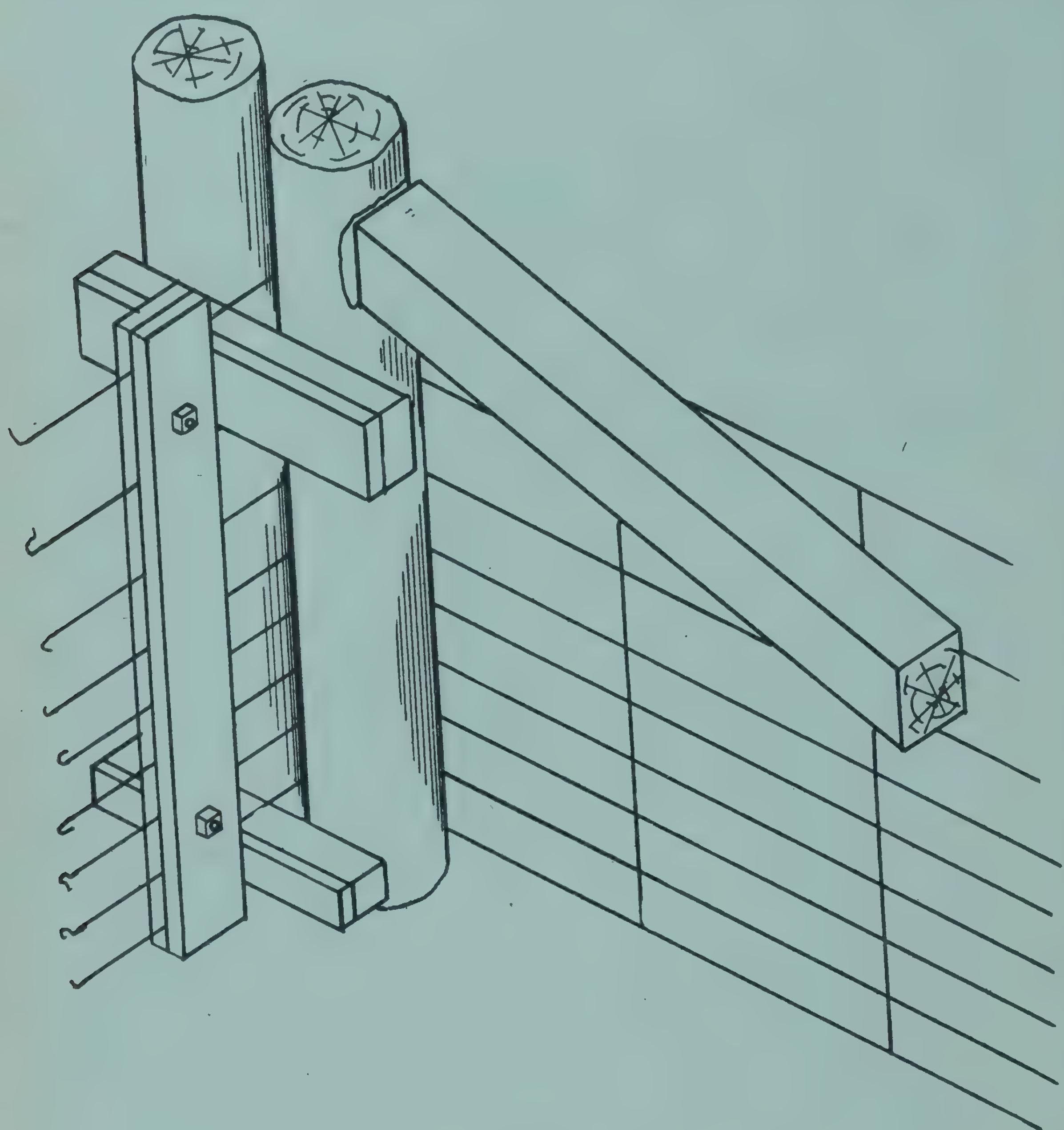


Fig. 49.

distance between the posts they will not interfere seriously with cultivation. Fig. 49 shows a contrivance devised for the attachment of a portable woven wire fence at the ends. Two posts cleated together at both top and bottom about four inches apart, are set in line with the fence at each end. If the woven wire is stapled to the end posts firmly enough to hold it, the fence will be badly damaged in withdrawing the staples to remove it, so that it would soon be destroyed. In order to overcome this difficulty, we bolt two pieces of one-by-four inch oak on the fence in the form of clamps, placing these clamps one on each side of an upright wire to prevent slipping of the laterals. This is then

drawn through between the two posts at one end and blocked by two-by-fours. A wire stretcher is then attached to the other end; the fence is pulled up tight; the end drawn through between the end posts and clamps and blocks used as heretofore described. The stretcher can then be slacked back and removed. The wire fence is held in an upright position against the intermediate posts by staples only partly driven. It required but two hours to release, move and again set up 358 feet of fence this way. In some cases it may be necessary to pin the fence

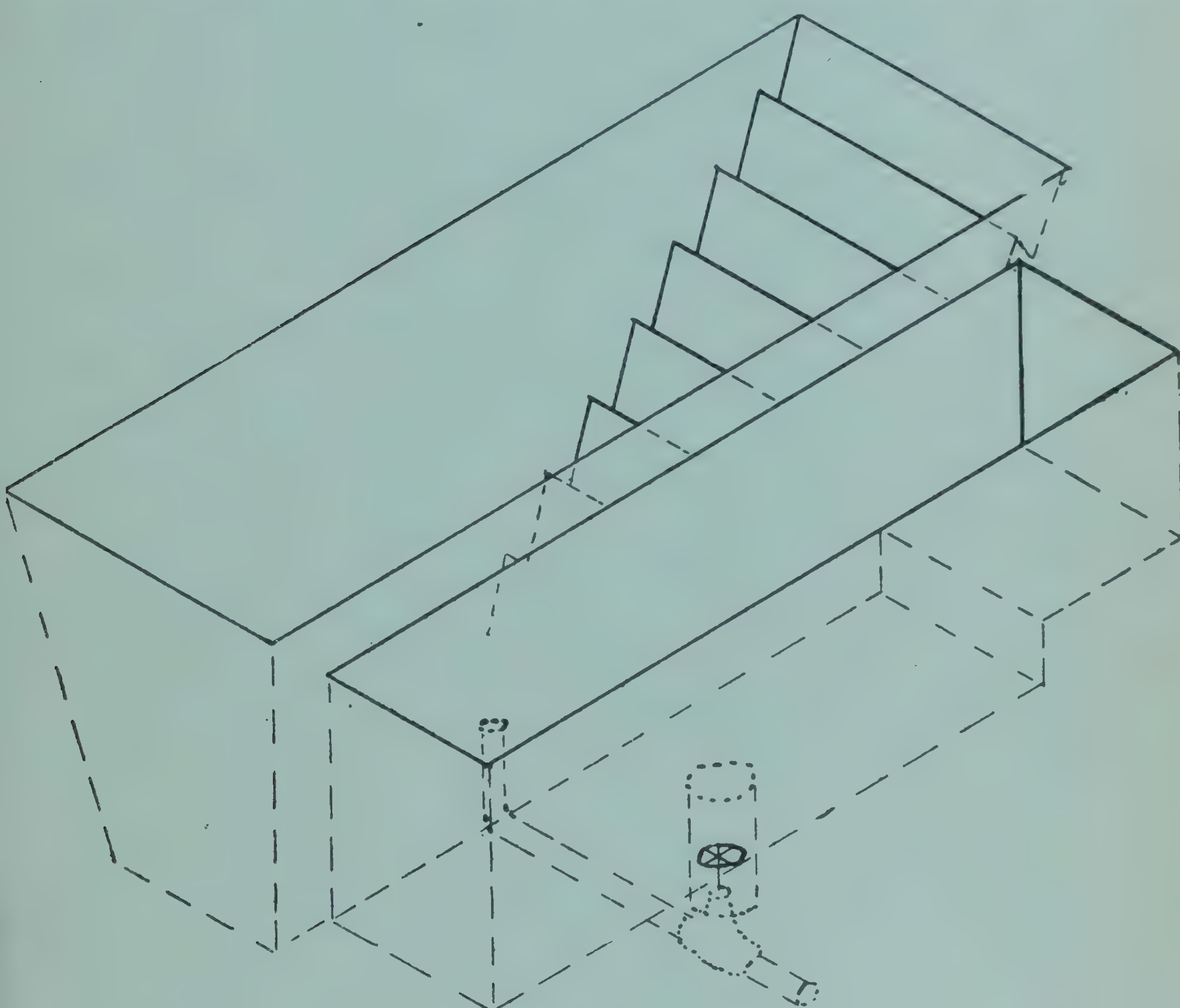


Fig. 50.

down between the posts but the occasion for this seldom occurs till the feed becomes too short. Occasionally sags will occur in the ground where pins would be lifted by the tension of the wire. In such cases the fence can be held down in the following manner, viz.: Wrap a short piece of wire around a rock or piece of wood, bury this underneath the fence and fasten the bottom strand of the fence down to the wires which project above ground from the rock. For portable fencing we have used thirty-inch woven wire which seems to be plenty high enough. A strand of barbed wire affords effective restraint when placed underneath a woven wire fence and is particularly desirable beneath permanent ones.

The Dipping Vat.—Fig. 50 represents the form of dipping vat in use in the piggery, the location of which is shown in Fig. 39. This vat is

constructed entirely of concrete. It is three feet deep, seven feet six inches long on top and three feet six inches long on bottom. It is eighteen inches wide on the bottom and thirty at the top. The end next the passageway is perpendicular, requiring the animals to plunge in; the other end is sloping with creases in the cement forming little steps to enable sheep and hogs to walk out. Adjacent to the vat and separated from it by an eight-inch cement partition, is a dry chamber five and-one half feet long, two and one-half feet deep, and eighteen inches wide, for an attendant to stand in and hold or handle sheep, as the vat is used for both sheep and hog dipping. One end of this chamber is raised nearly a foot to enable the attendant to assist sheep up the incline. The cement floor around the vat is so graded that the drippings are returned to it. This illustration shows, also, the drain pipe leading to an underdrain with the valve in the dry chamber below the floor level of this part. This vat was easily constructed, inexpensive, durable, and is entirely satisfactory.

INSECTS OF 1907.

BY R. H. PETTIT.

Bulletin No. 251.

INTRODUCTORY.

The present bulletin deals with a few of the insects of 1907, either new to our state or of special interest just at this time.

The writer wishes to emphasize the fact that he is always glad to receive specimens of insects or of their work, and in return to name them when possible and to give advice as to methods of control. Send specimens when possible, in tight, tin boxes with few if any holes. Send to the Entomologist of Experiment Station.

The writer also wishes to express his thanks to Mr. E. J. Kraus, who was student assistant during the summer of 1907 and whose help in the field has been of great value. Some of the photographs were made by Mr. Kraus and some by the writer.

Entomologist of Experiment Station,
Michigan Agricultural College,
East Lansing, Michigan.

THE OATS THRIPS.

(*Anaphothrips striatus.*)

Early in June disquieting reports commenced to come in, relative to the condition of the oats crop. The weather had been dry and pretty warm for a short time previous, although the cold, wet spring had made everything weeks late. However, to return to the condition of the oats, which were for the most part as yet unheaded, the alarming symptoms showed themselves in the reddening of the foliage and in the general sickly appearance of the plants. At first, rust was suspected, but the characteristic pustules of this disease were not to be found. A closer examination of some of the leaves showed that the much affected surfaces had been scraped by some feeble agent, some patches showing freshly scraped surfaces of small size. In others the surfaces had become white, reminding one of a slate pencil mark. In patches of greater age, these surfaces became reddish and finally the dying cells blackened and died, producing dead black surfaces. Such leaves also commenced to turn purple as a whole. A glance at such a leaf, with the aid of a strong magnifying lens, usually revealed the cause of the difficulty in the form of a tiny insect called a thrips. These little creatures are very small indeed, measuring only about one-twentieth of an inch in length, slender and of a yellow and brownish color.

Fig. 1.—Adult Thrips, greatly enlarged. Original.

The trouble seemed to spring up suddenly and without warning, all over the state, from the copper country on the north to Indiana and Ohio on the south. The writer saw it as far north as Alger county and received specimens from still farther north. In travelling over the state in any direction, one saw the effects of the depredations of this creature in all directions and at that time, viz., the part of June, the outlook was more than discouraging.

The oats that were least advanced suffered the most, those which had commenced to head out managing to withstand the attacks more successfully.

Fig. 2.—Immature Thrips, greatly enlarged.

The writer was considerably at a loss to know just what the outcome would be unless we had rain. It is well known that thrips do

not thrive in wet weather, on the other hand requiring hot, dry conditions for their best good. Fortunately, rain came in time to save the greater part of the crop, many of the thrips dying off and their depredations diminishing.

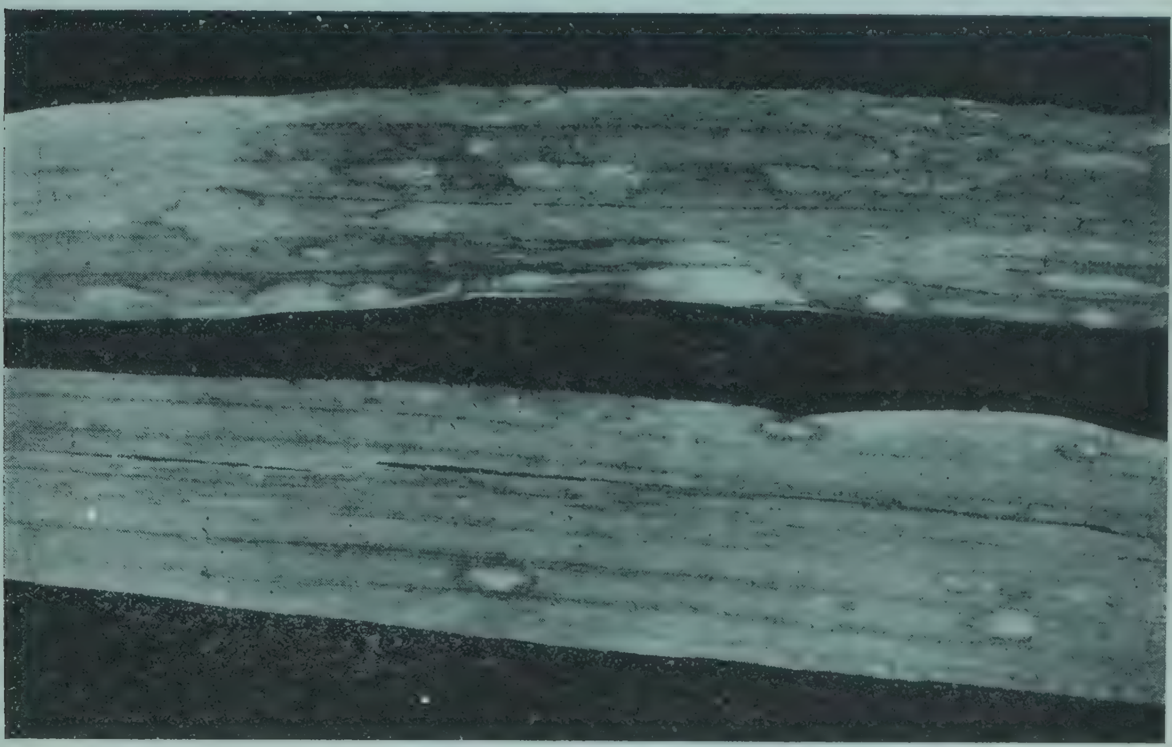


Fig. 3.—Work of Thrips on leaves of Oats, enlarged. Original.

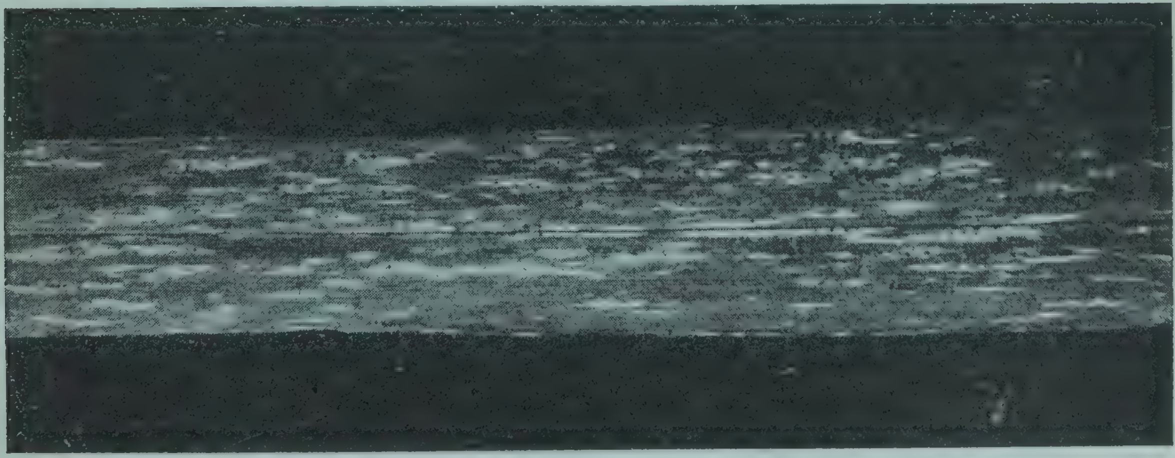


Fig. 4.—Work of Thrips on leaves of Oats, enlarged. Original.

Recovery from the injury was fairly rapid in fields where the grain was headed out and where the leaves were unfolded; the water seeming to wash off the pests except a few that succeeded in gaining shelter in the axils of the leaves. The younger plants, on the other hand, retained their quota of the insects longer, owing to their habit, as Mr. Kraus discovered, of hiding in the crevice left by the unrolling of the leaf blade. Here they would work inward as the leaf

unrolled, feeding on the fresh and tender leaf surfaces and more secure from the moisture than anywhere else. Here the pests lived on for some little time, but as the rain continued plentifully until the foliage was well out, a good proportion of the plants succeeded in getting heads and producing seed—not so abundantly as could be desired but a fairly good crop considering what they had been through.

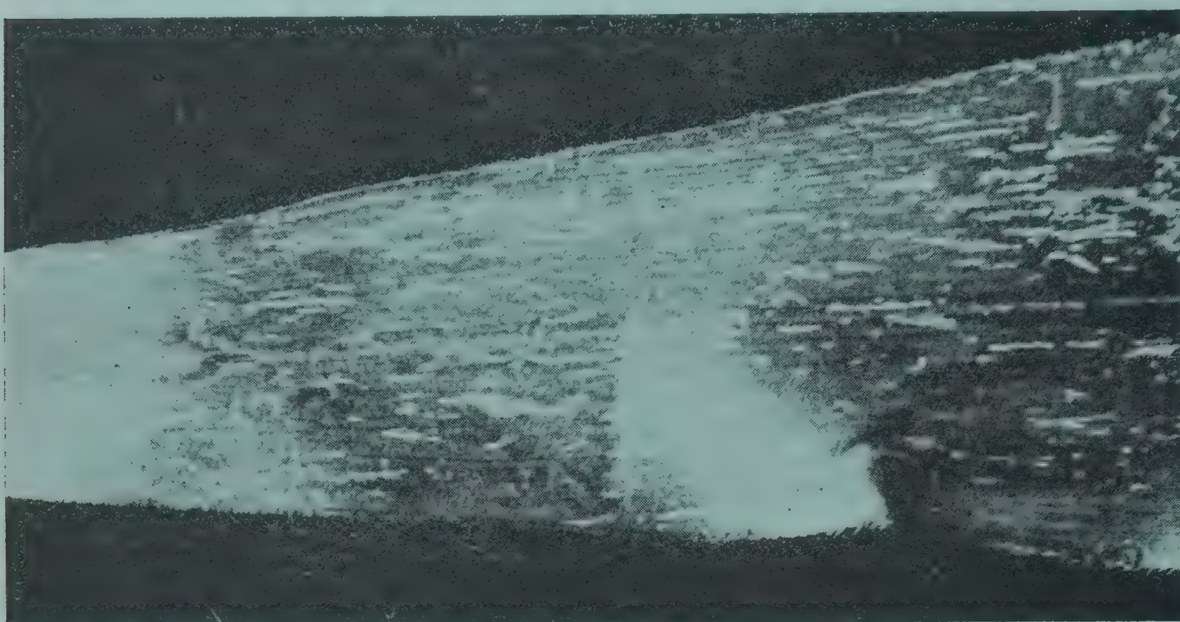


Fig. 5.—Leaf of Corn affected by Oat Thrips, enlarged. Original.

An examination of the corn plants showed about the same condition of affairs, the under sides of the blades showing characteristic markings and the thrips themselves being present and at work. Mr. Kraus found the pests also present on milkweed.

Description of *Anaphothrips striatus.*

Thorax buff with dark-brown markings; abdomen buff with broad dorsal stripe, often ill-defined, bordered laterally with narrow yellow stripes; legs and abdomen buffy, tinged with yellow, under surface almost egg-yellow; wings smoky; eyes purple, three ocelli orange; antennae buff at base, shading to brown at tip.

For a technical description see "Thysanoptera of N. A." in the Proceedings of the National Museum, Vol. XXVI, p. 161, by Dr. W. E. Hinds, who kindly determined the species at the request of Dr. F. M. Webster, to whom material was referred.

A somewhat similar attack was recorded in Insect Life, Vol. III, p. 301, in which it is stated that Dr. Roland Thaxter, in the annual report of the Connecticut Station for 1889, notices an attack of an insect that proved to be a thrips (probably *Thrips trifasciata*) which was confused with rust.

There arose a very natural confusion of this pest with the so called "Green bug," which was the cause of much anxiety the past year, especially in the southwest. The Green bug is a plant-louse which feeds on grasses, grains, corn and other hosts, producing a reddening of the

foliage and, in very many particulars, producing results similar to those brought about by thrips. Many reports of the Green bug were brought in, but no one was able to produce the insect itself which should have been plentiful if accountable for the results obtained. We ourselves made careful search and obtained material from many places and while we found occasional plant lice, we failed to find the real *Toxoptera graninum,* which is commonly known as the "Green bug."

We believe the past outbreak of thrips to be due to the unusually late spring which was followed by a hot dry spell just suited to the needs of the pests. The oats were held back and had to endure hot summer conditions before they were sufficiently grown to endure them. In other words, the thrips, always present in small numbers, got a chance at the oats before the leaves had a chance to expand and become tough enough to withstand the attack. It is hoped that such another spell of weather will not occur in many years, but in any case clean culture will help to keep the pest in reduced numbers and further than that there seems to be no need.

PENTATOMIDS FEEDING ON POTATO BEETLES.

(*Perillus claudus.*)*

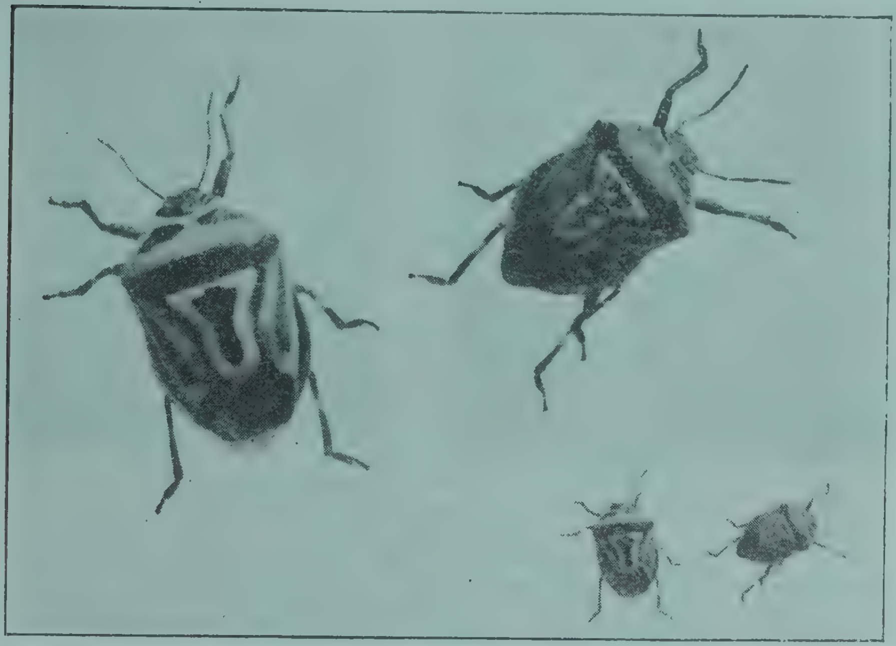


Fig. 6.—*Perillus claudus*, natural size and enlarged. Original.

The name stink-bug generally brings to mind the little evil tasting creature that one finds in berries when eating from the bushes. Many stink-bugs or pentatomids, however, are beneficial in their habits. One in particular appeared during the summer of 1907, in the potato fields

*Determined by Dr. Heidemann of the U. S. Dept. of Agriculture, Bureau of Entomology.

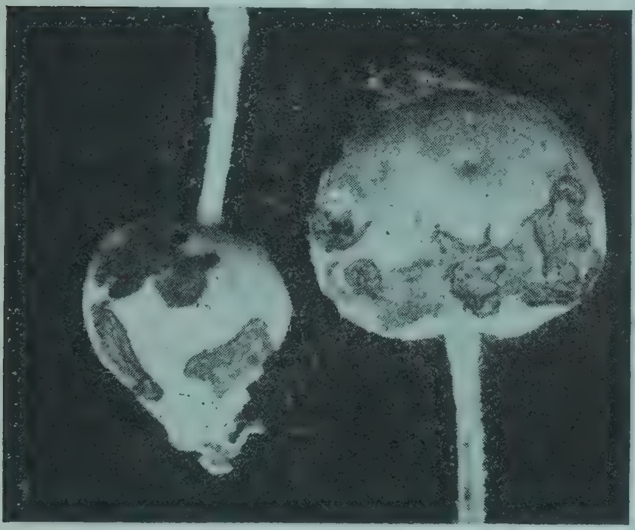
all over the state and did noble service in killing off potato-bettles. These bugs were seen repeatedly piercing the larvae of the beetles and sucking them dry. Indeed, we were told by some farmers that this work was so effective on certain farms as to make it unnecessary to spray for the bugs.

It is to be hoped that this lowly but friendly bug will thrive with us, but we would advise everyone to keep right on spraying just as in the past, for it is more than likely that something will happen to keep down their numbers in the future.

TUSSOCK-MOTH.

(*Notolophus leucostigma.*)

An old offender is the tussock-moth, its history being familiar enough to all. Every one is acquainted with the prettily colored caterpillars and with the cocoons, on which are laid the eggs by the wingless females. The larvae, however, took to feeding on the young fruit the past season in a manner utterly unprecedented in this part of the



Figs. 7 & 8.—Apples eaten by Tussock-moth, natural size. Original.

country at least. Many samples of young apples were sent in, small apples the size of a pea or of a cherry, each of which had been partially eaten out by the caterpillars. At first, green fruit worms were suspected, but many cases occurred where the larvae were found actively at work. The appearance of such fruit, when about one-quarter grown, is rather discouraging, since a large proportion of the fruit remains on the tree for some time. Figs. 7 and 8 show the general appearance of such fruit after being partially eaten by the tussock-moth.

CLOVER-HAY WORM.

(*Pyralis costalis.*)

Considerable loss has been occasioned of late by an old offender, the clover-hay worm. This creature does not attack the clover until it is put in the stack or in the mow, when it commences to spin its silken webs through the hay, binding everything more-or-less loosely with a mass of whitened webby waste. About the borders of the pile and in the crevices between the boards are placed the small white cocoons, which but add to the general injury. The bottom of the stack usually suffers most severely. Throughout this mass are to be found the small, dirty-white caterpillars which wriggle about when disturbed, dropping on silken threads in attempts to get away. Stock refuses to eat hay when badly webbed, and the loss is often very considerable.

Fig. 9.—Clover-hay moth, enlarged. Original.

REMEDIES.

All methods of control look to the destruction of the remains of old infested clover hay before the new crop is harvested. Clean out the mows and destroy the webbed hay, preferably by fire, in the spring, before putting in the new crop. Care in doing this will be well repaid later. The adult moths appear in early June and infested hay should be destroyed before this time. Where it is possible to avoid it, do not place new stacks on top of the remains of old ones, or even on the same ground.

THE BEAN-MAGGOT.

(*Pegomyia fusciceps.*)

For many years Michigan has borne more-or-less complainingly the ravages of the onion-maggot and of the cabbage-maggot, which latter also attacks the radish.

We have been on the outlook for the third member which is needed to complete this trio of root maggots, viz., the bean-maggot. Last summer this expected pest made itself known in a field of beans at the College.

On July 5th, just as the beans were nicely up above the ground, a large proportion of the young plants showed the effects of unusual at-

tacks. The cotyledons were blackened or browned, and in many cases the plumule or young shoot was shriveled and dead. Larvae and pupae of the maggot were found either in decaying cotyledons or in the fleshy stems beneath the surface of the soil.

Specimens of these larvae and pupae were collected and placed in suitable cages in which adults were found on July 22d.

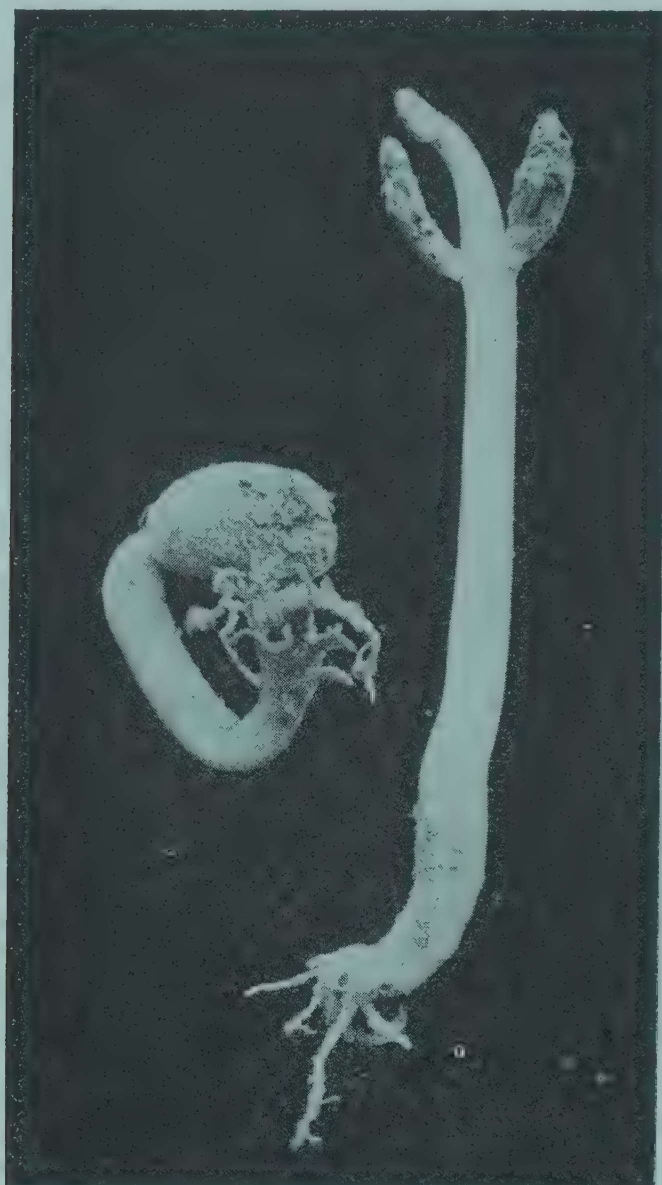


Fig. 10.—Young Bean plants affected by Bean-maggot, enlarged. Original.

These flies clearly resemble the adults of their relatives, the onion-maggot and the cabbage-maggot, being in appearance something like the house-fly, but considerably smaller. As this fly is reported as feeding on a number of other plants, it is likely that there is more than one brood each year. It is also likely that treatment with carbolic acid emulsion will repel the adult flies and prevent to a large degree the laying of eggs as in the case of the onion-maggots and the cabbage-maggots.

ROSE CHAFER.

(*Macrodactylus subspinosus.*)

Our hereditary enemy, the rose-chafer, or rose beetle, has of late been making such bold invasions into the grape territory that any measures which promise even partial success are welcome to the vineyard owners.

The life history of this awkward creature is known pretty well by those interested; the eggs are laid usually in sod land and in well-drained, sandy sod by preference, just such land as abounds in the fruit belt. The larvae are white grubs, resembling, in minature, the grubs of the ordinary white grub of the June-beetle. Like their larger relatives, they feed on the roots of vegetation. They attain their full size in the fall, and at that time hollow out small cells in the soil, where they pass the winter. In the spring the larvae change to pupae and, later in June, the adult beetles, with their long awkward legs, come out and spread over the country-side, collecting in regions where their food plants are to be found, new legions appearing from day to day as earlier ones die or are killed off, sometimes collecting in almost unbelievable numbers.

Grapes suffer most of all the fruits. The beetles seem to come out just in time to feast on the flowers and young sets, and a single beetle can account for many bunches of grapes at such a time.

On just such an occasion, the writer, in company with his assistant, Mr. E. J. Kraus, visited a vineyard at Decatur, a well-known grape region. Here a pan 7 ft. 6 in. long, 22 in. wide and 1 in. deep was made from a sheet of galvanized iron. To one side of this was fastened a light frame 3 ft. high and running the entire length of the frame, being securely braced to the frame of the pan. The pan was prepared by placing a number of old pieces of cloth, soaked in water, in the bottom and over this pouring about a quart of kerosene. When the pan had been made ready, it was placed alongside of a vine and the beetles beaten into it by means of switches made of broom corn. After collecting the beetles from one vine the pan was moved along to the next and the beating repeated. Some of the beetles fell short of the pan, some struck the shield and bounded back, but most of them stayed in and died. It is likely that a deep notch in the side of the pan, which would admit of placing the pan closer to the vines, would make it possible to catch more of the beetles. Of course, all the beetles that touched the oil died.

Quite a large number of beetles were collected in this way, but on the day of the trial the beetles were not so plentiful as the writer has seen them at other times. It is likely that when the beetles are not numerous, two men with ordinary milk pans, with oil rags in the bottom and with switches would do about as well. When very numerous the large pan should be efficient. It requires hard work to carry such a pan over the hills, such as are ordinarily used for grape growing. Fig. 11 shows such a pan in use.

Fig. 11.—Rose-chafer catcher in use in a vineyard. Original.

A test of arsenate of lead in heavy doses was also made at the same time. A certain portion of the vineyard was sprayed with arsenate, using four pounds to the barrel of water. The ordinary prepared paste was used. We started with a well-stirred charge, but owing to the inefficiency of the agitator, the application was far stronger at the part first sprayed than when farther along.

As to the results of the spray, Mr. E. V. Hayden, in whose vineyard the test was made, writes in substance, under date of October 26th: "In the north block where the spray was strong, the unsprayed rows averaged a little more than half as much as the average of the two rows that were sprayed. The beetles had been at work for a week when the spray was applied. No injury to the vines resulted from the strongest of the mixture."

This looks very encouraging, but the grower must always keep in mind that the spraying must be done thoroughly, everything must be hit and all parts of the vine washed with the mixture. Also use a pump with an agitator which will work when the pump is moving slowly.

ANOMALA ON APPLE.

(*Anomala binotata.*)

On the 5th of June, 1907, a lot of small beetles were received from Mr. W. T. Welch, of Paw Paw, who reported that the beetles were becoming serious to young apple trees. A visit to Paw Paw was made on the 7th and numbers of the beetles were seen, both at the farm of Mr. Welch and on nearby farms. The beetles were feeding on apple foliage and their work was, of course, most noticeable when the trees attacked were of small size. Young trees of one year suffered most. Numbers of beetles were found beneath the surface of the soil near the bases of these young trees.

Fig. 12.—Apple Anomala, natural size and enlarged. Original.

The beetles measure about 7-16 of an inch in length. They are stout and resemble their relative, the June-beetle in form, also like the June-beetles, they are clumsy in their movements. In color they are for the most part, polished black, except for the wing-covers, which are washed with bronzy straw color, the feet and antennae being dark brown. The underside of the body is coated with fine light hairs.

REMEDIES.

Like the June-beetle, this small relative readily responds to a spray of one of the arsenites, Paris-green or arsenate of lead, or any one of the reliable arsenical sprays will control it. In the case of small trees, as in the present instance, hand picking often suffices.

STRAWBERRY CROWN-GIRDLER ON PEACH.

(*Otiorhynchus ovatus.*)

In Bulletin 224 of December, 1906, is mention of the occurrence of the strawberry crown-girdler working on strawberry. During the past year this beetle appeared in a role new to us, viz., that of a feeder on peach foliage. The creature is known to feed on apple leaves, borage and other plants.

On July 15th, we received a letter with specimens of the adult beetle from Mr. B. B. Pratt, of Benton Harbor, Mich. Mr. Pratt records them as feeding on the leaves of young peach twigs growing near the crotch of the trees. He says, in a later letter: "In the morning I find them huddled in crevices of the bark, in the crotch of the tree, or between close-lying leaves."

Beetles to the number of a dozen or so were enclosed in a cage, with fresh peach twigs, on which they continued to live for weeks.

THRIPS ON OATS.

R. H. PETTIT.

*Special Bulletin No. 38.

From all parts of the state, complaints are coming in with respect to the condition of the oat crop. The last week has seen a notable change in the outlook. The young oats in a large part of the state have suddenly become as if stricken by blight, the outer leaves turning yellow and afterwards reddish until, after a little time, the field appears as if badly rusted. A closer examination shows that there are few if any rust pustules and the appearance on the surface is just enough different from that produced by rust to raise a doubt as to the real cause of the difficulty.

Careful examination with the aid of a powerful lens shows the culprit to be a minute insect called a thrips, very small, and very quick in its movements, jumping like a flea when disturbed and disappearing completely. These little creatures have narrow wings with fringes of long hairs instead of the ordinary form of wings. They scrape the surfaces of the oat leaves and cause them to become withered and to turn yellow and die. Now, this little creature has never before been seen in numbers by the writer and it is very difficult to judge just what will be the outcome of the infestation. If one might judge by the behavior of its relatives one would expect the condition to improve after one or two good rains, since thrips, in general, thrive in hot, dry weather, and do not do well when it is moist. However, it seems to be quite serious in places where there has been a fairly good supply of rain. The larger the plants are, the better they fare.

Now, there seems to be nothing one can do to check the trouble at this time. If it were possible to stimulate the growth of the plants in any way it would be a benefit, but such a course seems to be impossible. All plant life seems to be more susceptible to insects when plants are in poor condition for any reason, and the backward, cold, wet spring furnishes a very sufficient reason for the lack of vigor and resisting power which they should have to help repel the invaders.

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*The reports of the South Haven Sub-Station, and of the Upper Peninsula Sub-Station, both of which appeared in the 1907 Report as No. 38, are now numbered in the series of special bulletins 40 and 41, respectively, and hence these numbers will not appear in the 1908 Report.

POLLINATION OF FORCED TOMATOES.

BY S. W. FLETCHER AND O. I. GREGG.

Special Bulletin No. 39.

The objects of these experiments were to determine the extent to which the irregularity and small size of some greenhouse tomatoes are due to imperfect pollination; and also to ascertain whether there is any benefit to be derived from the cross-pollination of varieties as compared with self-pollination. Early in the winter of 1906 these questions were asked us by several Michigan greenhouse gardeners who had been having trouble with the setting of tomatoes under glass and especially with small and mis-shapen fruits.

Conditions of Experiment. The varieties used in 1906 were the Lorillard, a solid, dull red, flat variety; Frogmore, which is soft, round, bright red and a typical European forcing variety; and Best-of-All, which is quite similar to Lorillard, except that it has a brighter color. Twenty-four plants of each variety were grown in a three-quarter span greenhouse running East and West, on a wooden bench 50 feet long and 5 feet wide. There were four rows fifteen inches apart and the plants were 24 inches apart in the rows. They were grown to two stems.

Methods. There were six rows of four plants each of each variety. The plants of the first and sixth rows were used for pollen, the remaining plants being used for the crosses. The flowers of the first plant of the second row of each variety were emasculated and pollinated on one side of the stigma only, to learn if irregular, one-sided tomatoes are caused in this way. The flowers of the second plant of the same row were emasculated, and a large amount of pollen was spread over the whole surface of the stigma. The flowers of the third plant was emasculated, but only a small amount of pollen was placed upon the stigma. The flowers of the fourth plant had only a very few pollen grains applied to each stigma, the endeavor being to use but one or two grains. A glass slide on which some pollen had been shaken was examined with a hand lens, and the stigma touched at the point where the smallest pollen mass had been separated from the rest. In some cases a single grain may have been applied, but usually from three to five grains must have reached the stigma.

The flowers of the third row of plants were enclosed in paper sacks before mature; they where emasculated and were pollinated with the pollen of the same variety. The flowers of the plants in the third and fourth rows were emasculated and pollinated with pollen of the other two varieties. In every case the sacks were placed over the cluster as soon as the first blossoms were emasculated and were taken off daily, or every other day, either to pollinate the blossoms first emasculated or to emasculate later blossoms in the cluster. The sacks were not permanently removed until all danger from cross-pollination had passed.

As the tomatoes ripened those from each plant were picked and weighed separately.

RESULTS IN 1906.

A large percentage of the fruits resulting where pollen was applied merely to one side of the stigma were very much one-sided. Upon cutting them open it was found that only one cell was full of pulp and seeds, the other cells being seedless and having grown together, the cell full of seeds taking up over one-half of the interior of the tomato.

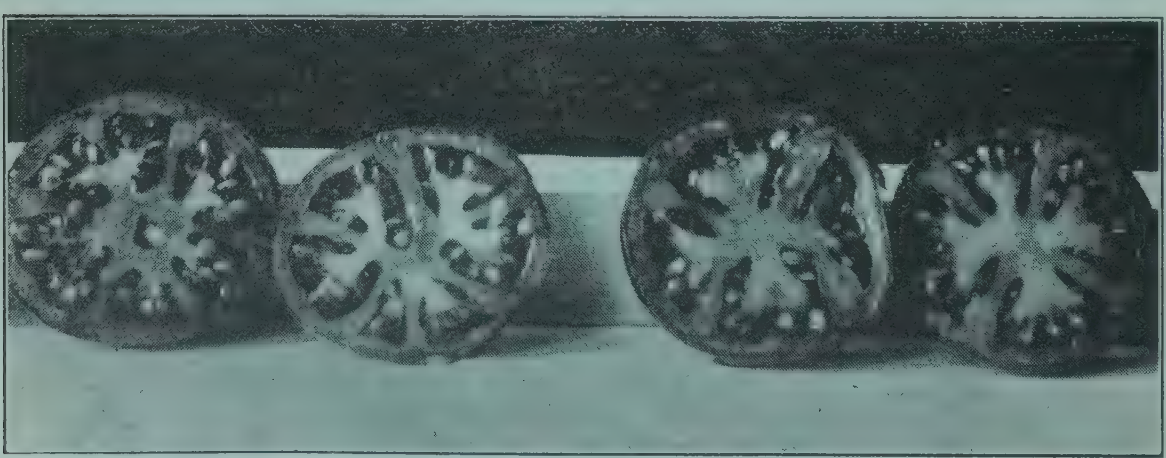
1. The Experiment in Progress.

The fruits produced from blossoms which had a large amount of pollen applied all over the stigma were smoother and averaged 14.7 grams heavier than those receiving a small amount of pollen over the stigma.

Striking results were obtained when only a very few pollen grains were applied to the stigma. When a pistil is not fertilized at all the whole flower, including the calyx, usually drops off. When only a few pollen grains were applied to the stigma quite a number of blossoms did not mature fruit but the calyx remained green and grew quite a little; while the tomato started to grow but soon withered. Those that did grow were slower in starting to enlarge than those from blossoms that received a liberal amount of pollen. The mature fruits on the plants

2. FROGMORE. On left, 4 self-pollinated fruits; in centre, 4 fruits from Best-of-All pollen; on right, 4 fruits from Lorillard pollen. No advantage from cross-pollination.

3. LORILLARD. On left, 4 self-pollinated fruits; in centre 5 fruits from Frogmore pollen; on right, 4 fruits from Best-of-All pollen. No advantage from cross-pollination.



4. BEST-OF-ALL. On right, 2 self pollinated fruits; on left, 2 fruits from Lorillard pollen. No advantage from cross-pollination.

thus pollinated were very small, averaging about 1 inch in diameter and weighing only from 20 to 40 grams, as compared with an average weight of 78 grams for the liberally-pollinated fruits. On cutting them open but one or two seeds were found in most cases, sometimes none; while a large forced tomato, well pollinated, usually contains about 230 seeds. These results indicate that, up to a certain limit, the more pollen the more seeds; and that the more numerous the seeds the larger the tomato, as a rule.

RESULTS OF CROSS-POLLINATION OF TOMATOES IN 1906.

The results with all three varieties showed that it was not necessary to cross pollinate them in order to obtain a good crop of large tomatoes. The self-pollinated blossoms set as well as the cross-pollinated, and there was practically no difference in the appearance or weight. On Frogmore the self-pollinated fruits weighed slightly more. The other two varieties showed no decisive benefit from cross-pollination.

Name of variety or cross.	No. of fruits.	Average weight.
Lorillard, self-pollinated	42	82 grams
Lorillard X Frogmore	39	84.9 grams
Lorillard X Best-of-All	26	80.5 grams
Frogmore, self-pollinated	39	74 grams
Frogmore X Lorillard	39	65.8 grams
Frogmore X Best-of-All	41	70 grams
Best-of-All, self-pollinated	46	75.4 grams
Best-of-All X Lorillard	40	74.8 grams
Best-of-All X Frogmore	55	75.6 grams

Average weight of self-pollinated fruits	77.1 grams
Average weight of cross-pollinated fruits	75.2 grams

The difference between the self and cross-pollinated fruits is so slight that we have concluded that these varieties were not benefited by cross-pollination.

EXPERIMENT OF 1907.

The experiment was conducted along the same lines and under the same conditions as that of the previous year, but with different varieties, Stirling Castle, Earliana and Ignotum being used.

Stirling Castle is a typical forcing tomato, generally having three cells, but sometimes two or four. It is very uniform in size and shape, small and not very bright in color. Earliana is much larger than Stirling Castle, is more crimson, but varies greatly in size and is generally quite irregular in shape. It is too irregular, and has too much "waste" to make a good forcing variety. Ignotum is a large, flat tomato, bright red and generally smooth, but varies considerably.

Methods. Seeds were sown the latter part of November. The plants were transplanted twice and put into four inch pots the first week in January. On February 10th they were transplanted into the bed used for the experiment in 1906. The plants were then topped and trained on the two-stem system. Emasculating and pollinating began as

soon as the first flowers showed. A few of the plants were slightly injured by blight and nematodes but the results were not seriously affected. In two cases the results with Earliana as the female parent were from one plant rather than from four because of a mistake in planting. The experiment was discontinued on May 3rd.

GENERAL RESULTS IN 1907.

The results corroborated those in 1906 in almost every point . Those blossoms pollinated with a small amount of pollen, on one side of the stigma only, produced lopsided tomatoes, the cell on the side pollinated having enlarged and not the others. The flowers fertilized with but one pollen grain, or as few as possible, gave even more striking results than in the previous year, as greater care was taken in pollinating. But very few of the fruits formed had over two seeds, some none at all. The tomatoes thus pollinated were very small and solid, no pulp being present. The roughness of their skin was also characteristic and the fruit was much duller in color. These fruits averaged but 35 grams in weight.

The results from pollinating with a large and with a small amount of pollen evenly distributed over the surface were not as conclusive as in the previous year. Stirling Castle tomatoes averaged 12 grams heavier on the plant pollinated with a large amount of pollen. The results of the two year's tests, however, indicate that the amount of pollen does to a great extent determine the size of the tomato. They show, however, that when a fair amount of pollen is applied evenly over the stigma no smaller tomato results than when a large amount of pollen is used, because the ability of the tomato to produce seed, and hence large fruit, is limited.

RESULTS OF CROSS-POLLINATION IN 1907.

Name of variety or cross.	No. of fruits.	Average weight.
Stirling Castle, self-pollinated	63	47 grams
Stirling Castle X Earliana	67	50.8 grams
Stirling Castle X Ignotum	75	47.4 grams
Earliana, self-pollinated	38	106 grams
Earliana X Stirling Castle	20	135 grams
Earliana X Ignotum	60	108.5 grams
Ignotum, self-pollinated	37	119 grams
Ignotum X Stirling Castle	33	131 grams
Ignotum X Earliana	39	13.4 grams

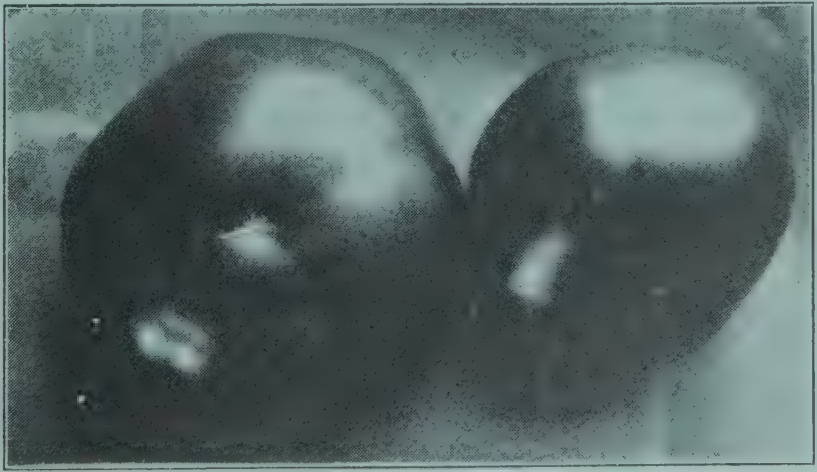
Average weight of all self-pollinated fruits....................77.6 grams
Average weight of all cross-pollinated fruits....................83.1 grams

The self-pollinated blossoms set as well as the cross-pollinated.

The average weight of cross-pollinated tomatoes in 1907 was 5.5 grams greater than that of the self-pollinated fruits; in 1906 it was 1.9 grams. In last year's experiment it was thought that cross-fertilization increased the number of cells of certain varieties, but this was not shown in the experiment of 1907. The number of cells in Stirling Castle (which generally has three cells, sometimes two or four), were noted in the crossed and self-pollinated tomatoes, but no difference could be seen.

5. Best of All. On right, 4 fruits from flowers which had a large amount of pollen, applied all over the stigma; on left, 4 fruits from flowers which had a very small amount of pollen. Showing the benefit of applying pollen freely.

6. Lorillard. Tomatoes produced by flowers which received but 1 to 5 grains of pollen. Very small, solid, and seedless or with 1 to 3 seeds.



7. Lorillard. On right, small lop sided tomato, the result of pollinating one side of the stigma only on left, large perfect tomato, the result of applying pollen all over the stigma.

SUMMARY OF EXPERIMENTS.

1. The six varieties under experiment were Ignotum, Stirling Castle, Earliana, Best-of-All, Lorillard and Frogmore. The blossoms on four plants of each variety were self-pollinated, and the blossoms of eight plants of each variety were cross-pollinated with two other varieties. All set fruit equally well. The 265 fruits produced from self-pollination on all six varieties had an average weight of 77.3 grams. The 534 fruits produced from cross-pollination on all six varieties had an average weight of 79.1 grams.

2. Four plants of each variety were used in an experiment to determine the effect of using varying amounts of pollen. All the flowers on one plant of each variety were emasculated and pollinated on one side of the stigma only. These invariably produced lop-sided and small fruits. All the flowers of one plant of each variety were pollinated with from one to five pollen grains. These produced very small, solid fruits, with an average weight of but 34 grams and having no seeds, or but one or two. All of the flowers on one plant of each variety were pollinated with a large amount of pollen, spread all over the stigma. These produced fruits that were smoother and averaged 12 grams heavier than fruits produced from flowers that had but a small amount of pollen applied all over the stigma.

CONCLUSIONS.

1. The results of the investigation indicate that it is not of primary importance to cross-pollinate any of the six varieties of forcing tomatoes used in these experiments, although it does no harm and may be a slight advantage in some cases.

2. When pollen falls upon one side of the stigma only, a one-sided tomato always results. The larger the stigma the greater the irregularity.

3. The amount of pollen applied to the stigma determines, to a great extent, the size and smoothness of the tomato; but after applying a certain amount of pollen no further increase in size or weight results by applying more. The small irregular tomatoes grown under glass are caused largely by insufficient pollination.

Similar results, as regards the effect of insufficient pollination, were obtained by Bailey (1) and Munson (2); and the conclusion that cross-pollination is not essential is supported by Troop (3), who found that Success tomato, when grown under glass, matured practically as many and as large tomatoes from self-pollination as from cross-pollination with Stone and Combination.

SUGGESTIONS TO TOMATO GROWERS.

The experiments indicate that it is not essential to grow several varieties for cross-pollination; but if more than one variety is grown, for any other reason, it is well to plant them in alternate rows, so that the pollen will be mixed as the pollinator passes from plant to plant. The experiments do show most conclusively, however, that the setting of a good crop of smooth, heavy fruit depends very largely upon the care taken in distributing the pollen. This is especially true during the cloudy

[1] Cornell (N. Y.) Ex. Sta. Bull. 28, pp. 53-55.
[2] Me. Ex. Sta. Rep't 1892, p. 49.
[3] Ind. Ex. Sta. Rep't 1904, p. 16-18.

weather of midwinter; less so when tomatoes are grown as a late winter and early spring crop, following lettuce, as is most common in Michigan. One of the largest losses in the forcing of tomatoes is the "waste;" the tomatoes that are too large, too irregular or too small for the high class trade. Attention to pollination insures a large proportion of smooth, medium sized tomatoes, if the variety is adapted for forcing, as are all the varieties mentioned, except Earliana. We prefer Lorillard and Frogmore.

During the winter we find that it pays to go over the plants on sunny days, and sometimes on cloudy days, and tap each blossom with the finger or with a small stick. This shakes the pollen out upon a small glass slide or spoon held in the left hand, and at the same time rubs the end of the pistil in the pollen already on the slide. The blossoms may be brushed over more rapidly with a camel's hair brush, but we have not found this method as satisfactory as the preceding. During a succession of sunny days in winter, and especially during the bright, warm days of early spring, the pollen seems to be distributed sufficiently if the vine is shaken or tapped with a padded stick on sunny days, between eleven and two o'clock. This is especially true of the Lorillard. A high temperature favors the bursting of the pollen sacks, even during cloudy weather, so it is best to run the house as high as is expedient during the days when pollen should fly; but not at night. It is also essential to keep the house dry during the brighter part of the day, as the pollen is discharged most freely in a hot, dry atmosphere. The anthers do not burst freely until after the yellow petals have fully expanded and have begun to wither slightly.

The fact that tomato blossoms will usually remain receptive for several days if they do not receive pollen makes the management of this problem easier than if they were insistent on immediate pollination. We believe, however, that the practice which some growers follow of depending wholly upon jarring the vines for the distribution of pollen is often responsible for a light crop. In the brightest weather jarring is often sufficient, but if the pollen does not fly freely hand pollination will be worth the trouble. We have never heard of bees being used successfully for distributing tomato pollen, although they work well on cucumbers.

BACTERIAL ASSOCIATIONS IN THE SOURING OF MILK

BY CHARLES E. MARSHALL AND BELL FARRAND.

Special Bulletin No. 42.

INTRODUCTION.

Previous contributions, "A Preliminary Note on the Associative Action of Bacteria in the Souring of Milk," Special Bulletin 23; "Additional Work upon the Associative Action of Bacteria in the Souring of Milk," Special Bulletin 29, and "Extended Studies of the Associative Action of Bacteria in the Souring of Milk," Special Bulletin 33, all covering the same central idea, and leading to the same end, will be simply confirmed, and the conception much extended in this paper, dealing with a more intimate and extensive study of milk existing under ordinary dairy conditions.

This study involves approximately the entire microbial content of each sample. Hitherto, our investigations have been confined to selected micro-organisms. In this work, the micro-organisms isolated from a definite sample of milk are employed for purposes of association with the lactic micro-organism also isolated from the same sample.

A sample of milk produced under ordinary conditions is selected, the micro-organisms isolated by plating, pure cultures of each species established and these associated in cultures with the lactic micro-organism, also isolated along with the others from the same sample of milk. The dominant lactic micro-organism of each sample of milk, therefore, becomes the central biological agent with which each micro-organism isolated from the sample is associated.

Following in line with previous articles, results are based upon appearances of cultures, development of acid, and the number of micro-organisms, as compared with checks. The general plan of this work may be illustrated by the following scheme. Let the samples of milk be represented by I, II, III and IV; then allow the various kinds of micro-organisms of a given sample of milk, as (I), to be represented by

Ia Ib Ic Id Ie If Ig Ih

Let Ih stand for the dominant lactic micro-organism; then Ih will be associated separately in turn with Ia, Ib, Ic, Id, Ie, If, Ig, and the combination in each instance being represented as Ia + Ih, Ib + Ih, Ic + Ih, Id + Ih, Ie + Ih, If + Ih, Ig + Ih. Whenever a combination is subjected to observation, pure cultures of the individual species are run parallel with the combined culture, as:

Culture	Culture	Culture
Ia	Ia + Ih	Ih

By this means it becomes possible to note any deviations occurring in

the combination from the pure cultures used as checks and running parallel under exactly the same conditions.

It is not necessary in this article to discuss in general the symbiotic infections and fermentations. Some of these have been referred to in the previous contributions. It is desired to emphasize but one aspect of the problem under consideration in this article—the real significance of these microbial relations to actual dairy practices.

Selecting micro-organisms for demonstrating lactic relationship, as has been our practice in the past, is truly suggestive and seemingly conclusive, yet milk as it exists under commercial conditions is so fraught with microbial complications that it would scarcely be advisable to conclude from mere possibility. Accordingly it is hoped that the suggestions and tentative conclusions of the past may take a more permanent nature as final conclusions in the present. Each sample of milk will be considered by itself for the purpose of keeping the unity of the sample. A comparative study at the end will furnish sufficient data to illustrate the harmonies and discords of the various samples and the peculiarities existing within each will be discussed as they arise to our attention.

METHODS.

Each sample of milk was secured in Erlenmeyer flasks, the acidity* determined as soon as reaching the laboratory, and plates made in ordinary and whey agar. The flasks were then placed at a uniform temperature of 21° C. From time to time, as indicated under each sample, the acidity was determined and plates made for ascertaining the bacterial content. Any changes in the milk apparent to the eye were noted. All determinations of the above character ceased with the loppering of the milk.

As the plates developed the total count was made and an effort put forth to obtain some notion of the various kinds of micro-organisms present in each set of plates and their relative numbers. The study of the rise and fall of the different kinds of micro-organisms present in the given sample has its importance in the final conclusions to be gathered from the various combinations of the sample.

It would be a great advantage if the ordinary lactic fermentation of milk could be followed from beginning to end along with its various modifications and each deviation or change in the course noted with satisfactory accuracy. While approximation is suggestive and doubtless holds the investigator to a rigid course, yet a failure, as is really the case, in ascertaining exactly the number of micro-organisms of a given species existing in milk at a definite period of its fermentation and the reason for increase or decrease, as the case may be with each species, must leave many problems wide open for future determination.

In investigations which involve so many possibilities, it has not been the intention of the writers or is it feasible to attempt exhaustive work, but rather to hew to a line which may be a fair average of the many divergent lines which might be undertaken with profit in connection with our theme.

It would make our findings quite different had we chosen another temperature than 21° C at which the cultures were maintained; yet, had another temperature been chosen to compare with 21° C., the required work would have been doubled. Again, any change in temperature would be likely

*Acidity was always determined by deci-normal solution of sodium hydroxide with phenol-phthalein as an indicator.

to make a micro-organism, now without associate influence, possess some associate influence and vice versa. A few degrees of temperature may alter completely the entire development of a micro-organism.

The variation in the numbers of micro-organisms introduced in combination must also produce different results. This is not entirely within the control of the operator, hence causes much annoyance.

Other factors creep into this work and should be considered; yet with a constant temperature, constant milk, constant controls or checks, all conditions the same in every test, the results offer average comparative material.

The facts available even with present technique, are very valuable and throw much light upon the suggestive hidden mysteries of the natural lactic fermentation of milk. Although our present methods and technique making *accuracy* unattainable, are to be deprecated, still the results fortify our steps of progress. No doubt, what has been heretofore regarded to a greater or less extent as the simple, natural fermentation of milk, is in its associations a most highly complex fermentation. It is only the heavy burden of our ignorance that makes us consider it in the light of a simple problem.

In addition to the knowledge acquired by the study of the rise and fall of the different micro-organisms in a sample of milk, the plates made of each sample from time to time materially assisted in the isolation of the various species in pure culture.

All the care exercised on the start in the study of the samples of milk, as secured from the dairy, was designed primarily for use in the interpretation of pure and associate cultures, as well as to measure against the detailed results of combinations. The authors anticipated the importance of comparing the souring of a sample in its natural condition with the results which may follow from the study of the association of the various micro-organisms with the lactic micro-organisms.

As soon as the micro-organisms of a sample were isolated in pure cultures their life histories were carefully studied to the point where the identity of each was well established, making it impossible to duplicate results or duplicate associate micro-organisms. In these studies, morphological and cultural, no effort was spared to follow out identifying or differentiating features to satisfaction. When this was done the morphological and cultural studies of the micro-organisms ceased. No attempt was made to carry the work to identification of species, inasmuch as it was not regarded as especially pertinent to the theme.

Great attention was given to the isolation of the lactic micro-organism of the sample and the ascertaining of its relation to the souring of the milk. As will be seen later in the detailed records, this was not a difficult task because of the predominance of the lactic micro-organisms toward the end of the fermentation. It was, however, very important that the lactic micro-organism should be secured in pure culture and should be maintained in a vigorous form, because of its central position as a biological factor. To accomplish this, cultures of the lactic micro-organism were kept in milk and transfers frequently made.

Whenever it was desired to follow out in detail the associate studies, cultures in bouillon of such germs concerned were made and held for twenty-four hours. These twenty-four hour cultures usually gave very vigorous germs for transplanting. From these twenty-four hour cultures dilutions were made in seven-tenths of one per cent salt solution. The extent of these dilutions

varied with the cultures under study, as will be noted later in the detailed work. In making them, 1 c. cm. was the smallest measurement employed, because it was found that anything smaller would not give uniform results, although the pipettes were supposed to be accurately graduated to .1 and 1-100 c. cm. The flasks containing the solutions for dilution were 375 c. cm. Erlenmeyer flasks, in which was placed 99 c. cm of the suspending diluent. From the last dilution of a twenty-four hour culture, 1 c. cm. was transferred to the milk flasks which were also 375 c. cm. Erlenmeyer flasks, containing 100 c. cm. of litmus milk* The cultures consisted of the associate micro-organism and the lactic micro-organism together with the combined culture. The milk flasks inoculated may be designated thus, as

Ia, in which 1 c. cm. of the associate culture Ia, diluted as above and recorded under this particular combination, is added to one milk flask containing 100 c. cm. of litmus milk.

Ij, in which 1 c. cm. of lactic culture, Ij, diluted as above and recorded under this particular combination, is added to one milk flask containing 100 c. cm. of litmus milk.

Ia + Ij, in which 1 c. cm. of the associated culture, Ia, and 1 c. cm. of the lactic culture, Ij, each, diluted as above and recorded under this particular combination, is added to one milk flask containing 100 c. cm. of litmus milk.

This gives one milk flask culture of each micro-organism, Ia and Ij as checks against the combination Ia + Ij. These checks grew under identical conditions as the combination. The combination, therefore, differs only in having been inoculated with the same number of micro-organisms, Ia, as were placed in the milk flask culture Ia, and the same number of micro-organisms, Ij, as were placed in the milk flask culture Ij. The number of micro-organisms introduced into each was controlled by plating. The three milk flask cultures Ia, Ij, Ia + Ij, were placed at 21° C. and maintained at this temperature until Ia + Ij or Ij loppered. From time to time ordinary and whey agar plates were made to determine the number of micro-organisms present in each culture. Note was made of any visible changes and the acidity† determined. The records of the individual combinations will illustrate with what results this was accomplished.

SAMPLE I.

This sample of milk was secured from a ten gallon can, placed in the milk-room of the College stable and was taken as soon as the milkers had filled the can. The milk was received in sterile Erlenmeyer flasks and conveyed to the laboratory, where it was immediately plated and tested for acidity.

The flask of milk was then placed in a temperature room, at a temperature of 21° C. Plates were made from the flask of milk from time to time, as indicated later, and the milk tested for acidity at the time of each plating.

*Wherever milk was used for cultures in which combinations were to be made, such milk was invariably of the same lot, containing the same amount of litmus and sterilized in an identical manner. In other words, its treatment was identical in every instance. See article on "Extended Studies of the Associative Action of Bacteria in the Souring of Milk," in which "The Significance of Different Milks and Their Relation to Germ Development," is treated. Cent. f. Bakt. II, Bd. XV, p. 400.

†The matter of measuring the acidity of milk cultures has already been referred to by the senior author in his articles on "Aeration of Milk." Cent. f. Bakt. II, Bd. IX, p. 313. "Extended Studies of the Associative Action of Bacteria in the Souring of Milk." Cent. f. Bakt. II, Bd. XV, p. 400.

SAMPLE I.

Hours after milking.	Acidity of sample.	Total number of bacteria.	Relative number of different types. *							
			a	b	c	d	e	f	g	j
0	16°	530	12	5	5	6	2	1	0†	0
15½	16°	49,500	12	4	1	4	19	0	0	2
20½	16°	275,000	7	7	2	1	2	0	2	2
40⅓	16°	69,000,000	10	0	0	15	3	1	0	36
64⅓‡	87°	2,000,000,000	0	0	0	3	2	0	0	1100

*Should be read horizontally only and not vertically.
†When zero appears it means that no colonies of that type could be determined, or for some reason were not determined.
‡Since there was no appearance of any change in this sample, twenty-four hours was allowed to elapse. This was a mistake in judgment, for there ought to have been some record between 40⅓ hours and 64⅓ hours—the milk was loppered at 64⅓ hours.

COMBINATION Ia AND Ij.

Dilutions employed for inoculating milk flasks.

Culture Ia.......... 1 : 100,000,000
Culture Ij.......... 1 : 100,000,000

Number of bacteria Ia, introduced into milk flask Ia =4.
Number of bacteria, Ij, introduced into milk flask Ij = 6.
Number of bacteria, Ia and Ij, introduced into milk flask Ia + Ij = 4 + 6 = 10.

Changes in milk flasks apparent to eye.
Milk flask cultures prepared Wednesday, 3 p. m.
42 hours after inoculation, Friday, 9 a. m.
Ia—no change.
Ia + Ij—litmus red.
Ij—litmus red.
53 hours after inoculation, Friday, 8 p. m.
Ia—no change.
Ia + Ij—loppered.
Ij—litmus reddened; no lopper.
65 hours after inoculation, Saturday, 8 a. m.
Ia—no change.
Ia + Ij—loppered.
Ij—loppered more firmly.

Acid developed during changes.

Time after inoculation.	0 hrs.	23½ hrs.	42 hrs.	53 hrs.
Culture Ia	18°	18°	18°	18°
Culture Ia + Ij	18°	18°	24°	69°
Culture Ij	18°	18°	21°	33°

Bacterial Counts.
In 53 hours.
Culture Ia—300,000,000.
Culture Ia + Ij—2,900,000,000.
Culture Ij—1,000,000,000.
(In the combined culture, Ia + Ij, many of Ia were still visible, perhaps 500,000,000.)

COMBINATION Ib AND Ij.

Dilutions employed for inoculating milk flasks.

Culture Ib........... I : 1,000,000
Culture Ij........... 1 : 100,000,000

Number of bacteria, Ib, introduced into milk flask Ib = 20.
Number of bacteria, Ij, introduced into milk flask Ij = 9.
Number of bacteria, Ib and Ij, introduced into milk flask Ib + Ij = 20 + 9. = 29.

Changes in milk flasks apparent to eye.

Milk flask cultures prepared Wednesday, 3 p. m.

23 hours after inoculation, Thursday, 2 p. m.

Ib—unchanged.

Ib + Ij—unchanged.

Ij—unchanged.

41 hours after inoculation, Friday, 8 a. m.

Ib—no change.

Ib + Ij—litmus reduced.

Ij—litmus reduced.

65 hours after inoculation, Saturday 8 a. m.

Ib—no change.

Ib + Ij—loppered.

Ij—loppered.

Acid developed during changes.

Time after inoculation.	0 hrs.	23 hrs.	41 hrs.	65 hrs.
Culture Ib	18°	18°	19°	19°
Culture Ib + Ij	18°	18°	28°	81°
Culture Ij	18°	18°	30°	85°

Bacterial Counts.

In 65 hours.

Culture Ib—below 1,000,000.

Culture Ib + Ij—3,200,000,000.

Culture Ij—2,900,000,000.

COMBINATION Ic AND Ij.

Dilutions employed for inoculating milk flasks.

Culture Ic........... 1 : 100,000,000

Culture Ij........... 1 : 100,000,000

Number of bacteria, Ic, introduced into milk flask Ic = 2.

Number of bacteria, Ij, introduced into milk flask Ij = 3.

Number of bacteria, Ic and Ij, introduced into milk flask Ic + Ij = 2 + 3 = 5.

Changes in milk flasks apparent to eye.

Milk flask cultures prepared Monday, 3 p. m.

23 hours after inoculation, Tuesday, 2 p. m.

Ic—unchanged.

Ic + Ij—unchanged.

Ij—unchanged.

47 hours after inoculation, Wednesday, 2. p. m.

Ic—unchanged.

Ic + Ij—litmus reduced near bottom.

Ij—litmus reduced near bottom.

71 hours after inoculation, Thursday, 2 p. m.

Ic—unchanged.

Ic + Ij—litmus reduced except surface.

Ij—litmus reduced except surface.

114 hours after inoculation, Saturday, 9 a. m.

Ic—unchanged.

Ic + Ij—loppering slightly.

Ij—more noticeable loppering.

138 hours after inoculation, Sunday, 9 a. m.

Ic—unchanged.

Ic + Ij—loppered.

Ij—loppered more firmly.

Acid developed during changes.

Time after inoculation.	0 hrs.	23 hrs.	47 hrs.	71 hrs.	114 hrs.
Culture Ic	18°	18°	19°	20°	21°
Culture Ic + Ij	18°	18°	22°	28°	39°
Culture Ij	18°	18°	23°	31°	45°

Bacterial counts.

In 71 hours.

Culture Ic—No count.

Culture Ic +Ij—202,000,000.

Culture Ij—243,000,000.

COMBINATION Id AND Ij.*

Dilutions employed for inoculating milk flasks.

Culture Id.......... 1 : 100
Culture Ij.......... 1 : 10,000

Number of bacteria, Id, introduced into milk flask Id = 3,400.
Number of bacteria, Ij, introduced into milk flask Ij = 134,000.
Number of bacteria, Id and Ij, introduced into milk flask Id + Ij = 3,400 + 134,000 = 137,400.

Changes in milk flasks apparent to eye.
Milk flask cultures prepared Wednesday, 3 p. m.
24 hours after inoculation, Thursday, 3 p. m.
Id—unchanged.
Id + Ij—litmus reduced at bottom only.
Ij—litmus reduced at bottom only.
48 hours after inoculation, Friday, 3 p. m.
Id—much the same as on Thursday.
Id + Ij—much the same as on Thursday.
Ij—much the same as on Thursday.
73 hours after inoculation, Saturday, 4 p. m.
Id—unchanged.
Id + Ij—litmus reddened.
Ij—litmus reddened.

Acid developed during the changes.

Time after inoculation.	0 hrs.	24 hrs.	48 hrs.	73 hrs.
Culture Id.....................	18°	20°	21°	23°
Culture Id + Ij................	18°	25°	25°	27°
Culture Ij.....................	18°	23°	24°	27°

Bacterial Counts.
In 73 hours.
Culture Id—10,000,000.
Culture Id + Ij—164,000,000.
Culture Ij—117,000,000.

COMBINATION Ie AND Ij.

Dilutions employed for inoculating milk flasks.

Culture Ie.......... 1 : 1,000,000
Culture Ij.......... 1 : 100,000,000

Number of bacteria, Ie, introduced into milk flask Ie = 348.
Number of bacteria, Ij, introduced into milk flask Ij = 14.
Number of bacteria, Ie and Ij, introduced into milk flask Ie + Ij = 348 + 14 = 362.

Changes in milk flasks apparent to eye.
Milk flask cultures prepared Tuesday, 3 p. m.
23 hours after inoculation, Wednesday, 2 p. m.
Ie—no change.
Ie + Ij—litmus reduction almost complete.
Ij—litmus reduced at bottom only.
49 hours after inoculation, Thursday, 4 p. m.
Ie—no change.
Ie + Ij—litmus wholly reduced.
Ij—litmus partly reduced.
72 hours after inoculation, Friday, 3 p. m.
Ie—litmus slightly changed.
Ie + Ij—beginning to curd at bottom.
Ij—litmus reddened.

Acid developed duriug changes.

Time after inoculation.	0 hrs.	23 hrs.	49 hrs.	72 hrs.
Culture Ie.....................	18°	22°	25°	27°
Culture Ie + Ij................	18°	27°	35°	42°
Culture Ij.....................	18°	21°	25°	27°

*This test, which is the second, was interfered with because of the fact that the lactic micro-organism had lost vigor from artificial cultivation.

Bacterial Counts.
In 72 hours.
Culture Ie—1,000,000,000.
Culture Ie + Ij—1,300,000,000.
Culture Ij—111,000,000.

COMBINATION If AND Ij.

Dilutions employed for inoculating milk flasks.

Culture If............ 1 : 10,000
Culture Ij............ 1 : 1,000,000

Number of bacteria, If, introduced into milk flask If = 435.
Number of bacteria, Ij, introduced into milk flask Ij = 765.
Number of bacteria, If and Ij, introduced into milk flask If + Ij = 435 + 765 = 1200

Changes in milk flasks apparent to eye.
Milk flask cultures prepared Friday, 9 a. m.
30 hours after inoculation, Saturday, 3 p. m.
If—no change.
If + Ij—litmus reduced at bottom.
Ij—litmus reduced at bottom.
49 hours after inoculation, Sunday, 10 a. m.
If—no change.
If + Ij—litmus reduced at bottom.
Ij—litmus reduced at bottom.
77 hours after inoculation, Monday, 2 p. m.
If—no change.
If + Ij—litmus reddened.
Ij—litmus reddened.
101 hours after inoculation, Tuesday, 2 p. m.
If—no change.
If + Ij—litmus reddened and reduced at bottom.
Ij—litmus reddened and reduced at bottom.
121 hours after inoculation, Wednesday, 10 a. m.
If—no change.
If + Ij—curded.
Ij—curded.

Acid developed during changes.

Time after inoculation.	0 hrs.	30 hrs.	49 hrs.	77 hrs.	101 hrs.
Culture If.............	18°	21°	20°	21°	21°
Culture If + Ij.......	18°	24°	24°	37°	47°
Culture Ij.............	18°	24°	24°	37°	46°

Bacterial Counts.
In 101 hours.
Culture If—5,710,000 .
Culture If + Ij—452,000,000.
Culture Ij—453,000,000.

COMBINATION Ig AND Ij.

Dilutions employed for inoculating milk flasks.

Culture Ig............ 1 : 100
Culture Ij............ 1 : 10,000

Number of bacteria, Ig introduced into milk flask Ig = 44,800.
Number of bacteria, Ij, introduced into milk flask Ij = 48,100.
Number of bacteria, Ig and Ij, introduced into milk flask Ig + Ij = 44,800 + 48,100 = 92,900.

Changes in milk flasks apparent to eye.

Milk flask cultures prepared Wednesday, 3 p. m.

24 hours after inoculation, Thursday, 3 p. m.

Ig—unchanged.

Ig + Ij—litmus reduced at bottom and slightly reddened.

Ij—unchanged.

48 hours after inoculation, Friday, 3 p. m.

Ig—litmus reduced, except near surface which is reddened.

Ig + Ij—litmus reduced, except near surface which is reddened.

Ij—litmus slightly reddened.

67 hours after inoculation, Saturday, 10 a. m.

Ig—litmus wholly reduced.

Ig + Ij—litmus wholly reduced.

Ij—litmus reduced somewhat.

Acid developed during changes.

Time after inoculation.	0 hrs.	24 hrs.	48 hrs.	67 hrs.
Culture Ig	18°	22°	29°	30°
Culture IJ + Ij	18°	33°	39°	46°
Culture Ij	18°	23°	26°	28°

Bacterial Counts.

In 67 hours.

Culture Ig—511,000,000.

Culture Ig + Ij—1,750,000,000.

Culture Ij—372,000,000.

COMBINATION Ih AND Ij.

Dilutions employed for inoculating milk flasks.

Culture Ih	1 : 1,000,000
Culture Ij	1 : 100,000,000

Number of bacteria, Ih, introduced into milk flask Ih = 147.

Number of bacteria, Ij, introduced into milk flask Ij = 22.

Number of bacteria, Ih and Ij, introduced into milk flask Ih + Ij = 147 + 22 = 169.

Changes in milk flasks apparent to eye.

Milk flask cultures prepared Wednesday, 3 p. m.

25 hours after inoculation, Thursday, 4 p. m.

Ih—no change.

Ih + Ij—no change.

Ij—no change.

41 hours after inoculation, Friday, 8 a. m.

Ih—no change.

Ih + Ij—litmus reduced.

Ij—no change.

47¼ hours after inoculation, Friday, 2:15 p. m.

Ih—no change.

Ih + Ij—litmus red on surface, reduced below, loppered.

Ij—no perceptible change.

Acid developed during changes.

Time after inoculation.	0 hrs.	25 hrs.	41 hrs.	47 hrs.
Culture Ih	16°	16°	16°	16°
Culture Ih + Ij	16°	16°	32°	58°
Culture Ij	16°	16°	16°	17°

Bacterial Counts.

In 47¼ hours.

Culture Ih—460,000,000.

Culture Ih + Ij—2,400,000,000.

Culture Ij—320,000,000.

Culture.	No. bacteria introduced in culture.[4]	No.[3] bacteria when changed.	Acidity[3] when changed.	Culture appearance when changed.
Ia[2]	4	300,000,000	18°	no change.
Ia + Ij[1]	10	2,900,000,000	69°	loppered.
Ij	6	1,000,000,000	33°	litmus reddened; no lopper.
Ib[2]	20	1,000,000	19°	no change.
Ib + Ij	29	3,200,000,000	81°	loppered.
Ij	9	2,900,000,000	85°	loppered.
Ic[2]	2	No count	21°	unchanged.
Ic + Ij	4	202,000,000	39°	loppering slightly.
Ij	2	243,000,000	45°	more noticeable loppering.
Id	3400	10,000,000	23°	unchanged.
Id + Ij	137,400	164,000,000	27°	litmus reddened.
Ij	134,000	117,000,000	27°	litmus reddened.
Ie	348	1,000,000,000	27°	litmus slightly changed.
Ie + Ij	362	1,300,000,000	42°	beginning to curd at bottom.
Ij	14	111,000,000	27°	litmus reddened.
If	435	5,710,000	21°	no change.
If + Ij	1200	452,000,000	47°	litmus red; reduced at bottom.
Ij	765	453,000,000	46°	litmus red; reduced at bottom.
Ig	44,800	511,000,000	30°	litmus wholly reduced.
Ig + Ij	92,900	1,750,000,000	46°	litmus wholly reduced.
Ij	43,100	372,000,000	28°	litmus reduced somewhat.
Ih	147	460,000,000	16°	no change.
Ih + Ij	169	2,400,000,000	58°	litmus red on surface; reduced below; loppered.
Ij	22	320,000,000	17°	no perceptible change.

[1]Constant letter "j" represents the lactic micro-organism.
[2]Variable letters, a, b, c, etc., the associate micro-organism.
[3]Counts and acidities made at the same time unless otherwise designated.
[4]The column indicating the number of bacteria introduced, refers to the total number introduced nto the flask containing 100 c. cm. of milk.

MICRO-ORGANISMS OF SAMPLE I.

Ia.

Morphology. Bacillus.
Size—average diameter, .4 microns; length, .8 — 1.6 microns.
Motility—motile.
Staining—stains readily.

Gelatin Colony.
Filamentous.

Gelatin Stab.
Filiform, becoming arborescent at lower portions. Later, a saccate liquefaction occurs in the upper part of streak.

Inclined Agar.
It produces a glistening, heavy growth on the surface of the agar.

Bouillon.
Gives rise to a turbidity with sediment at bottom and a scum on the surface.

Potato.

Milk.
In about ten days there is a soft curd produced. See also chart combination Ia and Ij.

Fermentation of Sugars. (Dextrose, Lactose, Saccharose). No fermentation.

Proteolysis.
Gelatin liquefied. Action on casein not noted.

Biochemical tests.
Nitrates reduced. No indol, hydrogen sulphide or ammonia, noted.

Chromogenesis.
No pigment.

Ib.

Morphology. Bacillus.
Size—average diameter, .6 — .8 microns; length, .8 — 1.2 microns.
Motility—no motility noted.
Staining—stains readily.
Gelatin Colony.
Round, finely granular.
Gelatin Stab.
Filiform, gradually becoming infundibuliform.
Inclined Agar.
Heavy opaque growth; agar becoming discolored.
Bouillon.
Turbid, with sediment.
Potato.
Moist and abundant growth.
Milk.
Proteolytic action. Also see chart combination Ib and Ij.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). No fermentation.
Proteolysis.
Gelatin liquefied. Casein digested.
Biochemical tests.
Ammonia and hydrogen sulphide, noted.
Chromogenesis.
Yellow pigment.

Ic.

Morphology. Bacillus.
Size—average diameter, .8 microns ; length, 1 — 1.6 microns.
Motility—no motility noted.
Staining—stains readily.
Gelatin Colony.
Smooth, raised, round.
Gelatin Stab.
Filiform, becoming rhizoid.
Agar.
Opaque, heavy growth.
Bouillon.
Turbid, with sediment at bottom.
Potato.
Moist growth.
Milk.
Curded after ten days. Also see chart combination Ie and Ij.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). No fermentation.
Proteolysis.
Gelatin not liquefied. No action noted on casein.
Biochemical tests.
No indol, hydrogen sulphide, or ammonia, noted. Nitrates not reduced.
Chromogenesis.
Red.

Id.

Morphology. Micrococcus.
Size—average diameter, 1 — 1.2 microns.
Motility—no motility.
Staining—stains readily.
Gelatin Colony.
Round, granular, erose.
Gelatin Stab.
Filiform, becoming saccate.
Inclined Agar.
Glistening yellow white.
Bouillon.
Turbid, with sediment.
Potato.
Not noted.
Milk.
No change noted besides litmus reduced at bottom of culture tube. See also chart combination Id and Ij.

Fermentation of Sugars (Dextrose, Lactose, Saccharose). None noted.
Proteolysis.
Gelatin liquefied. No action noted on casein.
Biochemical tests.
No indol, hydrogen sulphide, or ammonia, noted. Nitrates slightly reduced.
Chromogenesis.
No pigment.

Ie.

Morphology. Bacillus.
Size—average diameter, .8 microns; length, ——
Motility—no motility noted.
Staining—stains readily. Does not take Gram's stain.
Gelatin Colony.
Round, grumose, undulate.
Stab Gelatin.
Filiform, echinulate.
Inclined Agar.
Spreading opalescent, yellow.
Bouillon.
Turbid, with sediment.
Potato.
Moist abundant growth.
Milk.
Digested. Also see combination Ie and Ij.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). None noted.
Proteolysis.
Liquefaction of gelatin not noted.
Biochemical tests.
No indol, hydrogen sulphide, or ammonia, noted. No reduction of nitrates.
Chromogenesis.
Orange yellow pigment.

If.

Morphology. Micrococcus.
Size—average diameter, .6 microns.
Motility—no motility noted.
Staining—stains readily.
Gelatin Colony.
Round, finely granular, lobate.
Gelatin Stab.
Filiform, beaded, becoming saccate.
Inclined Agar.
Dull white growth.
Bouillon.
Turbid, with sediment.
Milk.
No change noted.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). Not noted.
Proteolysis.
Gelatin liquefied.
Biochemical tests.
Ammonia noted. Trace of reduced nitrates.
Chromogenesis.
No pigment.

Ig.

Morphology. Bacillus.
Size—average diameter, .4 microns; length, .8 to 1 micron.
Motility—motile.
Staining—stains readily.
Gelatin Colony.
Round, finely granular.
Gelatin Stab.
Crateriform.
Agar
Dull growth.

Bouillon.
Turbid sediment at bottom with scum on surface.
Potato.
Not noted.
Milk.
Resembling lactic curd. See also chart combination Ig and Ij.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). Not noted.
Proteolysis.
Gelatin liquefied. No proteolytic action on casein noted.
Biochemical tests.
Hydrogen sulphide and reduction of nitrates, positive. Indol and ammonia, negative
Chromogenesis.
No pigment.

Ih.

Morphology. Bacillus.
Size—average diameter, .4 to .6 microns; length, .8 to 1 micron.
Motility—motile.
Staining—stains readily.
Gelatin Colony.
Round, finely granular, raised.
Gelatin Stab.
Saccate.
Inclined Agar.
Dull, spreading, opalescent.
Bouillon.
Turbid with sediment.
Potato.
Moist abundant growth.
Milk.
No change in seven days, eventually becoming curded. See also chart combination Ih and Ij.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). None noted.
Proteolysis.
Liquefaction of gelatin; no proteolytic action on casein noted.
Biochemical tests.
No production of indol, hydrogen sulphide, or ammonia. No reduction of nitrates.
Chromogenesis.
No pigment produced.

Ij.

Morphology. (Micrococcus) Bacillus.
Size—average diameter, .8 microns; length, about same as diameter
Motility—no motility.
Staining—stains readily.
Gelatin Colony.
Round, reticulate.
Gelatin Stab.
Filiform.
Inclined Agar.
Glistening, opalescent.
Bouillon.
Turbid, some sediment.
Potato.
Very slight growth.
Milk.
Curded readily. See also chart combinations with Ij.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). None.
Proteolysis.
None.
Biochemical test.
Indol, hydrogen sulphide, and ammonia, negative. Reduction of nitrates, negative.
Chromogenesis.
No pigment produced.

SAMPLE II.

The milk for this sample was taken from a ten gallon can placed in the stable to receive the milk from the milkers. It was, therefore, as fresh as could be secured from mixed milk and represented the product of several cows. The milk may he said to be of a better quality than ordinary milk. The sample thus obtained was taken to the laboratory in an Erlenmeyer flask having a capacity of 375 c. cm. After reaching the laboratory the acidity was determined and plates made. The milk was then placed at a uniform temperature of 21° C. From time to time the acidity of the milk was determined and plates made in order to follow the changes taking place in the germ content.

The methods followed in the study of this sample were identical with those employed in Sample I.

SAMPLE II.

Hours after milking.	Acidity of sample.	Total number of bacteria.	Relative number of different types.											
			a	b	c	d	e	g	h	i	j	k	m	x
0	16°	1,380	0	12	4	1	6	5	1	8	1	12	6	0
15	17°	720,000	147	97	0	3	0	0	0	0	0	0	0	475
21	23°	7,670,000	147	116	0	0	0	0	0	0	0	0	0	504
28	55°	423,000,000	....	....	....	....	....	....	....	....	....	....	....	....
69	69°	1,600,000,000	0	1	0	0	0	0	0	0	0	0	0	200

COMBINATION IIa AND IIx.

Dilutions employed for inoculating milk flasks.

Culture IIa.......... 1 : 10,000
Culture IIx.......... 1 : 1,000,000

Number of bacteria, IIa, introduced into milk flask IIa = 540.
Number of bacteria, IIx, introduced into milk flask IIx = 2,000.
Number of bacteria, IIa and IIx, introduced into milk flask IIa + IIx = 540 + 2,000 = 2,540.

Changes in milk flasks apparent to eye.

Milk flask cultures prepared Tuesday, 2 p. m.

20 hours after inoculation, Wednesday, 10 a. m.
IIa—unchanged.
IIa + IIx—unchanged.
IIx—unchanged.

48 hours after inoculation, Thursday, 2 p. m.
IIa—unchanged.
IIa + IIx—unchanged.
IIx—unchanged.

69 hours after inoculation, Friday, 11 a. m.
IIa—unchanged.
IIa + IIx—unchanged.
IIx—unchanged.

93 hours after inoculation, Saturday, 11 a. m.
IIa—unchanged.
IIa + IIx—soft curd.
IIx—soft curd.

Acid developed during changes.

Time after inoculation.	0 hrs.	20 hrs.	48 hrs.	69 hrs.	93 hrs.
Culture IIa...........	19°	18°	18°	18°	18°
Culture IIa + IIx....	19°	19°	19°	20°	69°
Culture IIx.	19°	19°	19°	19°	68°

Bacterial Counts.
In 93 hours.
Culture IIa—102,000,000.
Culture IIa + IIx—1,990,000,000.
Culture IIx—1,980,000,000.

COMBINATION IIb AND IIx.

Dilutions employed for inoculating milk flasks.

Culture IIb.......... 1 : 10,000
Culture IIx.......... 1 : 100,000,000

Number of bacteria, IIb, introduced into milk flask IIb = 17.
Number of bacteria, IIx, introduced into milk flask IIx = 127,000.
Number of bacteria, IIb and IIx, introduced into milk flask IIb + IIx = 17 + 127,000 = 127,017.

Changes in milk flasks apparent to eye.
Milk flask cultures prepared Thursday, 3 p. m.
24 hours after inoculation, Friday, 3 p. m.
IIb—no change.
IIb + IIx—litmus slightly reduced.
IIx—litmus slightly reduced.
43 hours after inoculation, Saturday, 10 a. m.
IIb—no change.
IIb + IIx—litmus reduced, no curd.
IIx—litmus reduced, soft curd.
72 hours after inoculation, Sunday, 3 p. m.
IIb—no change.
IIb + IIx—litmus reduced, curded
IIx—litmus reduced, curded.

Acid developed during changes.

Time after inoculation.	0 hrs.	24 hrs.	43 hrs.	72 hrs.
Culture IIb....................	19°	20°	21°	23°
Culture IIb + IIx..............	19°	21°	49°	85°
Culture IIx....................	19°	26°	58°	77°

Bacterial Counts.
In 72 hours.
Culture IIb—
Culture IIb + IIx—3,220,000,000.
Culture IIx—4,180,000,000.

COMBINATION IIc AND IIx.

Dilutions employed for inoculating milk flasks.

Culture IIc.......... 1 : 10,000
Culture IIx.......... 1 : 1,000,000

Number of bacteria, IIc, introduced into milk flask IIc = 29,000.
Number of bacteria, IIx, introduced into milk flask IIx = 275,000.
Number of bacteria, IIc and IIx, introduced into milk flask IIc + IIx = 29,000 + 275,000 = 304,000.

Changes in milk flasks apparent to eye.
Milk flask cultures prepared Monday, 3 p. m.
24 hours after inoculation, Tuesday, 3 p. m.
IIc—no change.
IIc + IIx=no change.
IIx—no change.
48 hours after inoculation, Wednesday, 3 p. m.
IIc—no change.
IIc + IIx—litmus reduced; soft curd.
IIx—litmus reduced; soft curd.

Acid developed during changes.

Time after inoculation.	0 hrs.	24 hrs.	48 hrs.
Culture IIc............................	22°	23°	23°
Culture IIc + IIx......................	22°	23°	64°
Culture IIx............................	22°	23°	62°

Bacterial Counts.

In 48 hours.

Culture IIc—442,000.
Culture IIc + IIx—2,210,000,000.
Culture IIx—2,300,000,000.

COMBINATION IId AND IIx.

Dilutions employed for inoculating milk flasks.

Culture IId.......... 1 : 1,000,000
Culture IIx.......... 1 : 1,000,000

Number of bacteria, IId, introduced into milk flask IId = 17.
Number of bacteria, IIx, introduced into milk flask IIx = 1,800.
Number of bacteria, IId and IIx, introduced into milk flask IId + IIx = 17 + 1,800 =1,817.

Changes in milk flasks apparent to eye.

Milk flask cultures prepared Tuesday, 3 p. m.

24 hours after inoculation, Wednesday, 3 p. m.
IId—no change.
IId + IIx—no change.
IIx—no change.

47 hours after inoculation, Thursday, 2 p. m.
IId—no change.
IId + IIx—no change.
IIx—no change.

71 hours after inoculation, Friday, 2 p. m.
IId—no change.
IId + IIx—litmus slightly reduced.
IIx—litmus slightly reduced.

91 hours after inoculation, Saturday, 10 a. m.
IId—no change.
IId + IIx—loppered.
IIx—loppered.

Acid developed during changes.

Time after inoculation.	0 hrs.	24 hrs.	47 hrs.	71 hrs.	91 hrs.
Culture IId...........	20°	20°	20°	20°	21°
Culture IId + IIx....	20°	20°	22°	26°	76°
Culture IIx...........	20°	20°	22°	26°	80°

Bacterial Counts.

In 91 hours.

Culture IId—1,330,000.
Culture IId + IIx—2,060,000,000.
Culture IIx—1,970,000,000.

COMBINATION IIe AND IIx.

Dilutions employed for inoculating milk flasks.

Culture IIe.......... 1 : 100
Culture IIx.......... 1 : 10,000

Number of bacteria, IIe, introduced into milk flask IIe = 2,050,000.
Number of bacteria, IIx, introduced into milk flask IIx = 285,000.
Number of bacteria, IIe and IIx, introduced into milk flask IIe + IIx = 2,050,000 + 285,000 = 2,335,000.

Changes in milk flasks apparent to eye.

Milk flask cultures prepared Thursday, 3 p. m.

23 hours after inoculation, Friday, 2 p. m.
IIe—no change.
IIe + IIx—no change.
IIx—no change.

42 hours after inoculation, Saturday, 9 a. m.
IIe—no change.
IIe + IIx—loppering.
IIx—litmus slightly reduced.

Acid developed during changes.

Time after inoculation.	0 hrs.	23 hrs.	42 hrs.
Culture IIe	18°	19°	20°
Culture IIe + IIx	18°	19°	56°
Culture IIx	18°	19°	38°

Bacterial Counts.

In 42 hours.
Culture IIe—745,000,000.
Culture IIe + IIx—2,080,000,000.
Culture IIx—1,210,000,000.

COMBINATION IIg AND IIx.

Dilutions employed for inoculating milk flasks.

Culture IIg.......... 1 : 100
Culture IIx.......... 1 : 1,000,000

Number of bacteria, IIg, introduced into milk flask IIg = 525,000.
Number of bacteria, IIx, introduced into milk flask IIx = 1,820.
Number of bacteria, IIg and IIx, introduced into milk flask IIg + IIx = 525,000 + 1,820 = 526,820.

Changes in milk flasks apparent to eye.

Milk flask cultures prepared Friday, 4 p. m.
18 hours after inoculation, Saturday, 10 a. m.
IIg—no change.
IIg + IIx—no change.
IIx—no change.
42 hours after inoculation, Sunday, 10 a. m.
IIg—no change.
IIg + IIx—litmus reduced and slimy.
IIx—litmus slightly reddened.
66 hours after inoculation, Monday, 10 a. m.
IIg—no change in color; slimy.
IIg + IIx—slimy curd and litmus reduced.
IIx—soft curd; litmus reduced.

Acid developed during changes.

Time after inoculation.	0 hrs.	18 hrs.	42 hrs.	66 hrs.
Culture IIg	21°	20°	20°	21°
Culture IIg + IIx	21°	22°	36°	79°
Culture IIx	12°	22°	31°	83°

Bacterial Counts.

In 66 hours.
Culture IIg—106,000,000.
Culture IIg + IIx—1,700,000,000.
Culture IIx—1,440,000,000.

COMBINATION IIh AND IIx.

Dilutions employed for inoculating milk flasks.

Culture IIh.......... 1 : 100.
Culture IIx.......... 1 : 100,000,000

Number of bacteria, IIh, introduced into milk flask IIh = 693,000.
Number of bacteria, IIx, introduced into milk flask IIx = 1,880.
Number of bacteria, IIh and IIx, introduced into milk flask IIh + IIx = 693,000 + 1,880 = 694,880.

Changes in milk flasks apparent to eye.

Milk flask cultures prepared Thursday, 2 p. m.
24 hours after inoculation, Friday, 2 p. m.
IIh—litmus reduced.
IIh + IIx—litmus reduced.
IIx—litmus reduced.
44 hours after inoculation, Saturday, 10 a. m.
IIh—litmus reduced.
IIh + IIx—litmus reduced and loppered.
IIx—litmus reduced and loppered.

Acid developed during changes.

Time after inoculation.	0 hrs.	24 hrs.	44 hrs.
Culture IIh...........................	21°	25°	25°
Culture IIh + IIx.....................	21°	24°	86°
Culture IIx...........................	21°	24°	84°

Bacterial Counts.

In 44 hours.

Culture IIh—Record destroyed.
Culture IIh + IIx—Record destroyed.
Culture IIx—Record destroyed.

COMBINATION IIi AND IIx.

Dilutions employed for inoculating milk flasks.

Culture IIi.......... 1 : 10,000
Culture IIx.......... 1 : 1,000,000

Number of bacteria, IIi, introduced into milk flask IIi = 2,190.
Number of bacteria, IIx, introduced into milk flask IIx = 1,630.
Number of bacteria, IIi and IIx, introduced into milk flask IIi + IIx = 2,190 + 1,630 = 3,820.

Changes in milk flasks apparent to eye.

Milk flask cultures prepared Friday, 2 p.m.

26 hours after inoculation, Saturday, 4 p. m.
IIi—no change.
IIi + IIx—no change.
IIx—no change.

48 hours after inoculation, Sunday, 2 p. m.
IIi—no change.
IIi + IIx—some change in litmus.
IIx—some change in litmus.

67 hours after inoculation, Monday, 9 a. m.
IIi—no change.
IIi + IIx—loppered.
IIx—loppered.

Acid developed during changes.

Time after inoculation.	0 hrs.	26 hrs.	48 hrs.	67 hrs.
Culture IIi.....................	19°	20°	20°	19°
Culture IIi + IIx...............	19°	20°	27°	82°
Culture IIx.....................	19°	19°	28°	78°

Bacterial Counts.

In 67 hours.

Culture IIi—4,000,000.
Culture IIi + IIx—3,300,000,000.
Culture IIx—1,900,000,000.

COMBINATION IIj AND IIx.

Dilutions employed for inoculating milk flasks.

Culture IIj.......... 1 : 1,000,000
Culture IIx.......... 1 ; 100,000,000

Number of bacteria, IIj, introduced into milk flask IIj = 1,480.
Number of bacteria, IIx, introduced into milk flask IIx = 17,300.
Number of bacteria, IIj and IIx, introduced into milk flask IIj + IIx = 1,480 + 17,300 = 18,780.

Changes in milk flasks apparent to eye.

Milk flask cultures prepared Monday 3 p. m.

24 hours after inoculation, Tuesday, 3 p. m.
IIj—no change.
IIj + IIx—no change.
IIx—no change.

48 hours after inoculation, Wednesday, 3 p. m.
IIj—litmus slightly reduced.
IIj + IIx—loppered.
IIx—beginning to lopper.

Acid developed during changes.

Time after inoculation.	0 hrs.	24 hrs.	48 hrs.
Culture IIj	21°	23°	30°
Culture IIj + IIx	21°	23°	66°
Culture IIx	21°	21°	58°

Bacterial Counts.

In 48 hours.
Culture IIj—225,000,000.
Culture IIj + IIx—2,400,000,000.
Culture IIx—1,600,000,000.

COMBINATION IIk AND IIx.

Dilutions employed for inoculating milk flasks.
Culture IIk.......... 1 : 10,000
Culture IIx.......... 1 : 1,000,000

Number of bacteria, IIk, introduced into milk flask IIk = 96,000.
Number of bacteria, IIx, introduced into milk flask IIx = 48,000.
Number of bacteria, IIk and IIx, introduced into milk flasks IIk + IIx = 96,000 + 48,000 = 144,000.

Changes in milk flasks apparent to eye.

Milk flask cultures prepared Thursday, 2 p. m.
24 hours after inoculation, Friday, 2 p. m.
IIk—no change.
IIk + IIx—litmus reduced.
IIx—litmus reduced.
44 hours after inoculation, Saturday, 10 a. m.
IIk—no change.
IIk + IIx—litmus reduced, loppered.
IIx—litmus reduced, loppered.

Acid developed during changes.

Time after inoculation.	0 hrs.	24 hrs.	44 hrs.
Culture IIk	21°	22°	23°
Culture IIk + IIx	21°	25°	83°
Culture IIx	21°	25°	86°

Bacterial Counts.

In 44 hours.
Culture IIk—15,800,000.
Culture IIk + IIx—4,890,000,000.
Culture IIx—5,850,000,000.

COMBINATION IIm AND IIx.

Dilutions employed for inoculating milk flasks.
Culture IIm.......... 1 : 10,000
Culture IIx.......... 1 : 100,000

Number of bacteria, IIm, introduced into milk flask IIm = 4,460.
Number of bacteria, IIx, introduced into milk flask IIx = 296,000.
Number of bacteria, IIm and IIx, introduced into milk flask IIm + IIx = 4,460 + 296,000 = 300,460.

Changes in milk flasks apparent to eye.

Milk flask cultures, prepared Thursday, 3 p. m.
20 hours after inoculation, Friday, 11 a. m.
IIm—no change.
IIm + IIx—no change.
IIx—no change.
44 hours after inoculation, Saturday, 11 a. m.
IIm—no change.
IIm + IIx—litmus reduced.
IIx—litmus reduced.

Acid developed during changes.

Time after inoculation.	0 hrs.	20 hrs.	44 hrs.
Culture IIm	19°	19°	20°
Culture IIm + IIx	19°	22°	48°
Culture IIx	19°	19°	54°

Bacterial Counts.
In 44 hours.
Culture IIm—2,330,000.
Culture IIm + IIx—3,590,000,000.
Culture IIx—2,920,000,000.

Culture.	No. bacteria introduced in culture.[4]	No. bacteria[3] when changed.	Acidity[3] when changed.	Culture appearance when changed.
IIa[2]	540	102,000,000	18°	unchanged.
IIa + IIx[1]	2,540	1,980,000,000	69°	soft curd.
IIx	2,000	1,990,000,000	68°	soft curd.
IIb[2]	17	....	23°	no change.
IIb + IIx	127,019	3,220,000,000	85°	litmus reduced.
IIx	127,000	4,180,000,000	77°	litmus reduced.
IIc[2]	29,000	442,000	23°	no change.
IIc + IIx	304,000	2,210,000,000	64°	litmus reduced.
IIx	275,000	2,300,000 000	62°	litmus reduced.
IId	17	1,330,000	21°	no change.
IId + IIx	1,817	2,060,000,000	76°	loppered.
IIx	1,800	1,970,000,000	80°	loppered.
IIe	2,050,000	745,000,000	20°	no change.
IIe + IIx	2,335,000	2,080,000,000	56°	loppering.
IIx	285,000	1,210,000,000	38°	litmus slightly reduced.
IIg	525,000	106,000,000	21°	no change in color; slimy.
IIg + IIx	526,820	1,700,000,000	79°	slimy curd, litmus reduced.
IIx	1,820	1,440,000,000	83°	soft curd, litmus reduced.
IIh	693,000	(record destroyed)	25°	litmus reduced.
IIh + IIx	694,880		86°	litmus reduced, loppered.
IIx	1,880		84°	litmus reduced, loppered.
IIi	2,190	4,000,000	19°	no change.
IIi + IIx	693,820	3,300,000,000	82°	loppered.
IIx	1,630	1,900,000,000	78°	loppered.
IIj	1,480	225,000,000	30°	litmus slightly reduced.
IIj + IIx	18,780	2,400,000,000	66°	loppered.
IIx	17,300	1,600,000,000	58°	beginning to lopper.
IIk	96,000	15,800,000	23°	no change.
IIk + IIx	144,000	4,890,000,000	83°	litmus reduced, loppered.
IIx	48,000	5,850,000,000	86°	litmus reduced, loppered.
IIm	4,460	2,330,000	20°	no change.
IIm + IIx	300,400	3,590,000,000	48°	litmus reduced.
IIx	296,000	2,920,000,000	54°	litmus reduced.

[1]Constant letter represents the lactic micro-organism.
[2]Variable letters, a, b, c, etc., the associate micro-organisms.
[3]Counts and acidities made at the same time unless otherwise designated.
[4]The column indicating the number of bacteria introduced refers to the total number introduced into the flask containing 100 c. cm. of milk.

MICRO-ORGANISMS OF SAMPLE II.

IIa.

Morphology. Bacillus.
Size—average diameter, 1.2 microns; length, 1.6 microns to 5.6 microns.
Motility—motile.
Staining—stains readily.
Gelatin Colony.
Filamentous.
Gelatin Stab.
Arborescent.
Agar.
Glistening, opaque growth.
Bouillon.
Sediment at bottom, supernatant liquid becoming clear.

Potato.
Moist abundant growth, becoming discolored.
Milk.
First curded, then digested. See also chart combination IIa and IIx.
Fermentation of Sugars (Dextrose, Lactose, Saccharose).
Proteolysis.
No liquefaction of gelatin noted.* Casein after some time digests.
Biochemical tests.
Indol, hydrogen sulphide, and ammonia, negative. No reduction of nitrates noted.
Chromogenesis.
No pigment.

IIb.

Morphology. Micrococcus.
Size—average diameter, .875 microns.
Motility—no motility.
Staining—stains readily.
Gelatin Colony.
Round.
Gelatin Stab.
Filiform, becoming infundibuliform and stratiform.
Agar.
Opaque.
Bouillon.
Turbid with slight sediment.
Potato.
Moist, abundant growth.
Milk.
Soft, flocculent curd, digesting.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). No fermentation noted.
Proteolysis.
Gelatin liquefied; casein digested.
Biochemical tests.
No indol, hydrogen sulphide, or ammonia, noted. Nitrates not reduced.
Chromogenesis.
No pigment.

IIc.

Morphology. Micrococcus.
Size—average diameter, .8 microns.
Motility—no motion.
Staining—stains readily.
Gelatin Colony.
Round, grumose.
Gelatin Stab.
Saccate, dull, opaque.
Bouillon.
Turbid, with slight sediment.
Potato.
Moist, abundant growth.
Milk.
Digestion complete in 24 hours.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). None noted.
Proteolysis.
Gelatin liquefied. Action on casein not noted.
Biochemical tests.
No indol, hydrogen sulphide, or ammonia, noted. Nitrates not reduced.
Chromogenesis.
No pigment.

IId.

Morphology. Micrococcus.
Size—average diameter, .8 microns.
Motility—no motion.
Staining—stains readily.

*Had this been held longer than ten days, some liquefaction might have been noted.

Gelatin Colony.
Grumose, ameboid.
Gelatin Stab.
Beaded.
Agar.
Dull, opaque.
Bouillon.
Scum with sediment.
Potato.
Abundant growth.
Milk.
Curded after 30 days. See also chart combination IId and IIx.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). None noted.
Proteolysis.
No liquefaction of gelatin. No action on casein noted.
Biochemical tests.
Indol, hydrogen sulphide, and ammonia, negative. Nitrates reduced.
Chromogenesis.
No pigment.

IIe.

Morphology. Bacillus.
Size—average diameter, .8 microns; length 1 microne to 1.8 microns
Motility—no motion
Staining—stains readily.
Gelatin Colony.
Round, clouded.
Gelatin Stab.
Filiform, becoming stratiform.
Agar.
Glistening, opaque.
Bouillon.
Slight sediment, faint ring at top. Body of liquid clearing.
Potato.
Moist, abundant growth.
Milk.
Curded after nine days. See also chart combination IIe and IIx.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). None noted.
Proteolysis.
Gelatin liquefied.
Biochemical tests.
Indol, hydrogen sulphide, negative. Nitrates reduced.
Chromogenesis.
Yellow pigment.

IIg.

Morphology. Bacillus.
Size—average diameter, .4 microns; length, 1 micron to 1.6 microns.
Motility—no motion.
Staining—stains readily.
Gelatin Colony.
Round, grumose.
Gelatin Stab.
Filiform.
Inclined Agar.
Glistening, opalescent.
Bouillon.
Turbid, slight scum.
Potato.
Moist, abundant growth.
Milk.
See combination IIg and IIx.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). None noted.
Proteolysis.
No liquefaction of gelatin. Casein unchanged.
Biochemical tests.
Indol, hydrogen sulphide, and ammonia, negative.
Nitrates, not reduced.

Chromogenesis.
No pigment.

IIh.

Morphology. Bacillus.
Size—average diameter, .8 microns; length, 1 micron to 1.6 microns.
Motility—no motion.
Staining—stains readily.
Gelatin Colony.
Round.
Gelatin Stab.
Filiform, becoming crateriform.
Inclined Agar.
Glistening, opaque.
Bouillon.
Turbid, with slight sediment.
Potato.
Moist, abundant growth.
Milk.
Slimy curd, becoming digested. See also combination IIh and IIx
Fermentation of Sugars (Dextrose, Lactose, Saccharose). Negative.
Proteolysis.
Gelatin liquefied. Casein digested.
Biochemical tests.
Indol, hydrogen sulphide, and ammonia, negative. Nitrates not reduced.
Chromogenesis.
Pink pigment.

IIi.

Morphology. Micrococcus.
Size—average diameter, .7 to .8 microns.
Motility—no motion.
Staining—stains readily.
Gelatin Colony.
Round.
Gelatin Stab.
Filiform, becoming saccate.
Inclined Agar.
Glistening, opaque.
Bouillon.
Turbid, slight sediment.
Potato.
Moist, medium growth.
Milk.
Soft curd after 18 days. Also see combination IIi and IIx.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). None noted.
Proteolysis.
Gelatin liquefied.
Biochemical tests.
Indol, hydrogen sulphide and ammonia, negative. Nitrates not reduced.
Chromogenesis.
No pigment.

IIj.

Morphology. Bacillus.
Size—average diameter, .4 microns; average length, .8 microns.
Motility—motile.
Staining—stains readily.
Gelatin Colony.
Round, grumose.
Gelatin Stab.
Filiform, becoming infundibuliform.
Inclined Agar.
Dull, opaque.
Bouillon.
Potato.
Moist, abundant growth.

Milk.
Smooth acid curd. See combination IIj and IIx.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). Dextrose fermented.
Proteolysis.
Gelatin liquefied. Casein, no action noted.
Biochemical tests.
Indol produced. Nitrates reduced. Hydrogen sulphide, and ammonia, negative.
Chromogenesis.
No pigment.

IIk.

Morphology. Micrococcus.
Size—average diameter, .8 microns.
Motility—no motion.
Staining—stains readily.
Gelatin Colony.
Round, grumose.
Gelatin Stab.
Filiform, becoming crateriform.
Inclined Agar.
Glistening, opaque.
Bouillon.
Turbid, with sediment.
Potato.
Abundant, dry growth.
Milk.
Curded in nine days. Also see chart combination IIk and IIx.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). Negative.
Proteolysis.
Gelatin liquefied. No change of casein noted.
Biochemical tests.
Indol, and hydrogen sulphide, negative. Nitrates not reduced.
Chromogenesis.
No pigment.

IIx.

Morphology. Bacillus.
Size—average diameter, .5 microns; length, .7 to .8 microns.
Motility—no motion.
Staining—stains readily.
Gelatin Colony.
Round, finely granular.
Gelatin Stab.
Filiform.
Inclined Agar.
Glistening, opaque, creamy white.
Bouillon.
Turbid, becoming clear, sediment at bottom.
Potato.
Abundant growth.
Milk.
Curded, acid. See also combinations with IIx.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). Negative.
Proteolysis.
Negative.
Biochemical tests.
No indol, hydrogen sulphide, or ammonia noted. Nitrates not reduced.
Chromogenesis.
No pigment.

SAMPLE III.

This sample was secured in the dairy and may be regarded as ordinary milk. It was placed in a sterilized flask and brought to the laboratory. Immediately plates were made and the acidity determined. The milk was then placed at a temperature of 21° C. The acidity was tested and plates made as indicated in the following work.

SAMPLE III.

Hours after milking.	Acidity of samples.	Total number of bacteria.	Relative number of different types.										
			a	b	c	e	f	g	h	i	j	k	x
0............	17°	221,000	4	2	.003	0	0	0	220	0	0	0	0
7............	17°	1,780,000	1	2	0	0	0	36	1782	0	.4	0	0
23............	19°	3,800,000	0	0	0	0	0	0	100	0	0	0	0
32............	19°	204,000,000	0	0	0	0	0	0	100	0	0	0	0
47............	43°	1,633,000,000	0	0	0	0	0	0	49	0	0	0	119
53............	63°	1,936,000,000	0	0	0	0	0	0	18	0	0	0	1939
71............	72°	854,000,000	0	0	0	0	0	0	1	0	0	0	854

COMBINATION IIIa AND IIIx.

Dilutions employed for inoculating milk flasks.

Culture IIIa......... 1 : 10,000
Culture IIIx......... 1 : 1,000,000

Number of bacteria, IIIa, introduced into milk flask IIIa = 115.
Number of bacteria, IIIx, introduced into milk flask IIIx = 2,240.
Number of bacteria, IIIa and IIIx, introduced into milk flask IIIa + IIIx = 115 + 2,240 = 2,355.

Changes in milk flasks apparent to eye.

Milk flask cultures prepared Wednesday, 10 a. m.

6 hours after inoculation, Wednesday, 4 p. m.
IIIa—no change.
IIIa + IIIx—no change.
IIIx—no change.

22 hours after inoculation, Thursday, 8 a. m.
IIIa—no change.
IIIa + IIIx—litmus lighter.
IIIx—no change.

54 hours after inoculation, Friday, 4 p. m.
IIIa—no change.
IIIa + IIIx—litmus nearly reduced.
IIIx—litmus slightly reduced.

70 hours after inoculation, Saturday, 8 a. m.
IIIa—no change.
IIIa + IIIx—firm curd.
IIIx—firm curd.

Acid developed during changes.

Time after inoculation.	0 hrs.	6 hrs.	22 hrs.	54 hrs.	70 hrs.
Culture IIIa..........	16°	16°	16°	16°	16°
Culture IIIa + IIIx...	16°	16°	17°	37°	87°
Culture IIIx..........	16°	16°	17°	21°	83°

Bacterial Counts.

In 54 hours.
Culture IIIa—157,000,000.
Culture IIIa + IIIx—857,000,000.
Culture IIIx—194,000,000.

COMBINATION IIIb AND IIIx.

Dilutions employed for inoculating milk flasks.

Culture IIIb......... 1 : 10,000
Culture IIIx......... 1 : 1,000,000

Number of bacteria, IIIb, introduced into milk flask IIIb = 7,670.
Number of bacteria, IIIx, introduced into milk flask IIIx = 2,660.
Number of bacteria, IIIb and IIIx, introduced into milk flasks IIIb + IIIx = 7670, + 2,660 = 10,330.

Changes in milk flasks apparent to eye.
Milk flask cultures prepared Thursday, 9 a. m.
8 hours after inoculation, Thursday, 5 p. m.
IIIb—no change.
IIIb + IIIx—no change.
IIIx—no change.
23 hours after inoculation, Friday, 8 a. m.
IIIb—no change.
IIIb + IIIx—no change.
IIIx—no change.
31 hours after inoculation, Friday, 4 p. m.
IIIb—no change.
IIIb + IIIx—no change.
IIIx—no change.
47 hours after inoculation, Saturday, 8 a. m.
IIIb—no change.
IIIb + IIIx—litmus slightly reduced.
IIIx—no change.
59 hours after inoculation, Saturday 8 p. m.
IIIb—no change.
IIIb + IIIx—soft curd.
IIIx—no change.

Acid developed during changes.

Time after inoculation.	0 hrs.	8 hrs.	23 hrs.	31 hrs.	47 hrs.	59 hrs.
Culture IIIb............	14°	14°	14°	14°	14°	14°
Culture IIIb + IIIx.....	14°	14°	14°	14°	17°	71°
Culture IIIx............	14°	14°	15°	15°	18°	20°

Bacterial Counts.
In 59 hours.
Culture IIIb—208,000,000.
Culture IIIb + IIIx—2,500,000,000.
Culture IIIx—222,000,000.

COMBINATION IIIc AND IIIx.

Dilutions employed for inoculating milk flasks.
Culture IIIc.......... 1 : 10,000
Culture IIIx.......... 1 : 1,000,000

Number of bacteria, IIIc, introduced into milk flask IIIc = 55,800.
Number of bacteria, IIIx, introduced into milk flask IIIx = 2,030.
Number of bacteria, IIIc + IIIx, introduced into milk flask IIIc + IIIx = 55,800 + 2,030 = 57,830.

Changes in milk flasks apparent to eye.
Milk flask cultures prepared Thursday, 10 a. m.
7 hours after inoculation, Thursday, 5 p. m.
IIIc—no change.
IIIc + IIIx—no change.
IIIx—no change.
22 hours after inoculation, Friday, 8 a. m.
IIIc—no change.
IIIc + IIIx—no change.
IIIx—no change.
29 hours after inoculation, Friday, 3 p. m.
IIIc—no change.
IIIc + IIIx—litmus slightly reduced.
IIIx—no change.
45½ hours after inoculation, Saturday, 7:30 a. m.
IIIc—no change.
IIIc + IIIx—firm curd.
IIIx—soft curd.

Acid developed changes.

Time after inoculation.	0 hrs.	7 hrs.	22 hrs.	31 hrs.	45½ hrs.
Culture IIIc............	14°	14°	15°	16°	16°
Culture IIIc + IIIx.. ..	14°	14°	15°	18°	71°
Culture IIIx............	14°	14°	15°	18°	61°

Bacterial Counts.

In 31 hours.

Culture IIIc—82,30300,000. In 24 hour .
Culture IIIc + IIIx—312,000,000.
Culture IIIx—116,000,000.

COMBINATION IIIe AND IIIx.

Dilutions employed for inoculating milk flasks.

Culture IIIe......... 1 : 10,000
Culture IIIx......... 1 : 1,000,000

Number of bacteria, IIIe, introduced into milk flask IIIe = 8,810.
Number of bacteria, IIIx, introduced into milk flask IIIx = 2,410.
Number of bacteria, IIIe and IIIx, introduced into milk flask IIIe + IIIx = 8,810 + 2,410 = 11,220.

Changes in milk flasks apparent to eye.

Milk flask cultures prepared Monday, 9 a. m.

8 hours after inoculation, Monday, 5 p. m.
IIIe—no change.
IIIe + IIIx—no change.
IIIx—no change.

24 hours after inoculation, Tuesday, 9 a. m.
IIIe—no change.
IIIe + IIIx—no change.
IIIx—no change.

31 hours after inoculation, Tuesday, 4 p. m.
IIIe—no change.
IIIe + IIIx—no change.
IIIx—no change.

47 hours after inoculation, Wednesday, 8 a. m.
IIIe—no change.
IIIe + IIIx—litmus reduced; loppering.
IIIx—slightly loppered.

71 hours after inoculation, Thursday, 8 a. m.
IIIe—no change.
IIIe + IIIx—loppered.
IIIx—loppered.

Acid developed during changes.

Time after inoculation.	0 hrs.	8 hrs.	24 hrs.	31 hrs.	47 hrs.	71 hrs.
Culture IIIe............	19°	19°	18°	19°	17°	18°
Culture IIIe + IIIx.....	19°	19°	19°	19°	56°	87°
Culture IIIx............	19°	19°	19°	19°	61°	98°

Bacterial Counts.

In 47 hours.

Culture IIIe—1,030,000 (24 hour count).
Culture IIIe + IIIx—2,230,000,000.
Culture IIIx—2,410,000,000.

COMBINATION IIIf AND IIIx.

Dilutions employed for inoculating milk flasks.

Culture IIIf......... 1 : 10,000
Culture IIIx......... 1 : 1,000,000

Number of bacteria, IIIf, introduced into milk flask IIIf = 160,000.
Number of bacteria, IIIx, introduced into milk flask IIIx = 18.
Number of bacteria, IIIf and IIIx, introduced into milk flask IIIf + IIIx = 160,000 + 18 = 160,018.

Changes in milk flasks apparent to eye.

Milk flask cultures prepared Monday, 9 a. m.

7 hours after inoculation, Monday, 4 p. m.
IIIf—no change.
IIIf + IIIx—no change.
IIIx—no change.

24 hours after inoculation, Tuesday, 9 a. m.
IIIf—no change.
IIIf + IIIx—no change.
IIIx—no change.

31 hours after inoculation, Tuesday, 4 p. m.
IIIf—no change.
IIIf + IIIx—no change.
IIIx—litmus slightly reduced.
48 hours after inoculation, Wednesday, 9 a. m.
IIIf—litmus changing to red.
IIIf + IIIx—litmus reduced.
IIIx—litmus becoming red.
53 hours after inoculation, Wednesday, 2 p. m.
IIIf—litmus red.
IIIf + IIIx—soft curd.
IIIx—soft curd.

Acid developed during changes.

Time after inoculation.	0 hrs.	7 hrs.	24 hrs.	31 hrs.	48 hrs.	53 hrs.
Culture IIIf............	14°	14°	14°	25°	44°	44°
Culture IIIf + IIIx.....	14°	14°	17°	26°	45°	61°
Culture IIIx............	14°	14°	14°	14°	41°	69°

Bacterial Counts.
In 53 hours.
Culture IIIf—2,130,000,000.
Culture IIIf + IIIx—5,800,000,000.
Culture IIIx—1,100,000,000.

COMBINATION IIIg and IIIx.

Dilutions employed for inoculating milk flasks.

Culture IIIg.......... 1 : 10,000
Culture IIIx......... 1 : 1,000,000

Number of bacteria, IIIg, introduced into milk flask IIIg = 10,800.
Number of bacteria, IIIx, introduced into milk flask IIIx = 2,350.
Number of bacteria, IIIg and IIIx, introduced into milk flask IIIg + IIIx = 10,800 + 2,350 = 13,150.

Changes in milk flasks apparent to eye.
Milk flask cultures prepared Monday, 8 a. m.
8 hours after inoculation, Monday, 4 p. m.
IIIg—no change.
IIIg + IIIx—no change.
IIIx—no change.
24 hours after inoculation, Tuesday, 8 a. m.
IIIg—no change.
IIIg + IIIx—no change.
IIIx—no change.
33 hours after inoculation, Tuesday, 5 p. m.
IIIg—ropy.
IIIg + IIIx—litmus reduced; ropy.
IIIx—litmus very slightly reduced.
47½ hours after inoculation, Wednesday, 7:30 a. m.
IIIg—litmus slightly reduced; ropy.
IIIg + IIIx—litmus reduced; slimy.
IIIx—litmus reduced.

Acid developed during changes.

Time after inoculation.	0 hrs.	8 hrs.	24 hrs.	33 hrs.	47½ hrs.
Culture IIIg..........	16°	16°	16°	21°	28°
Culture IIIg + IIIx...	16°	16°	17°	25°	61°
Culture IIIx.	16°	16°	16°	19°	42°

Bacterial Counts.
In 47½ hours.
Culture IIIg—1,400,000,000.
Culture IIIg + IIIx—2,300,000,000.
Culture IIIx—1,500,000,000.

COMBINATION IIIh AND IIIx.

Dilutions employed for inoculating milk flasks.

Culture IIIh......... 1 : 10,000
Culture IIIx......... 1 : 1,000,000

Number of bacteria, IIIh, introduced into milk flask IIIh = 898.
Number of bacteria, IIIx, introduced into milk flask IIIx = 3,800.
Number of bacteria, IIIh + IIIx, introduced into flask milk IIIh + IIIx = 898 + 3,800 = 4,698.

Changes in milk flasks apparent to eye.
Milk flask cultures prepared Monday, 8 a. m.
9 hours after inoculation, Monday, 5 p. m.
IIIh—unchanged.
IIIh + IIIx—unchanged.
IIIx—unchanged.
24 hours after inoculation, Tuesday, 8 a. m.
IIIh—unchanged.
IIIh + IIIx—unchanged.
IIIx—unchanged.
33 hours after inoculation, Tuesday, 5 p. m.
IIIh—litmus very slightly reduced.
IIIh + IIIx—litmus very slightly reduced.
IIIx—no change.
48 hours after inoculation, Wednesday, 8 a. m.
IIIh—litmus slightly reduced.
IIIh + IIIx—litmus slightly reddened.
IIIx—litmus slightly reddened.
54 hours after inoculation, Wednesday, 2 p. m.
IIIh—litmus slightly reduced.
IIIh + IIIx—litmus wholly reduced.
IIIx—red; loppering.

Acid developed during changes.

Time after inoculation.	0 hrs.	9 hrs.	24 hrs.	33 hrs.	48 hrs.	54 hrs.
Culture IIIh............	15°	15°	15°	15°	15°	14°
Culture IIIh + IIIx.....	15°	15°	15°	15°	26°	37°
Culture IIIx............	15°	15°	15°	15°	35°	52°

Bacterial Counts.
In 54 hours.
Culture IIIh—127,000,000.
Culture IIIh + IIIx—1,300,000,000.
Culture IIIx—1,700,000,000.

COMBINATION IIIi and IIIx.

Dilutions employed for inoculating milk flasks.

Culture IIIi..........1 : 10,000
Culture IIIx......... 1 : 1,000,000

Number of bacteria, IIIi, introduced into milk flask IIIi = 134.
Number of bacteria, IIIx, introduced into milk flask IIIx = 3,070.
Number of bacteria, IIIi and IIIx, introduced into milk flask IIIi + IIIx = 134 + 3,070 = 3,204.

Changes in milk flasks apparent to eye.
Milk flask culture prepared, Monday, 8 a. m.
9 hours after inoculation, Monday, 5 p. m.
IIIi—unchanged.
IIIi + IIIx—unchanged.
IIIx—unchanged.
24 hours after inoculation, Tuesday, 8 a. m.
IIIi—unchanged.
IIIi + IIIx—unchanged.
IIIx—unchanged.
33 hours after inoculation, Tuesday, 5 p. m.
IIIi—unchanged.
IIIi + IIIx—litmus slightly reduced.
IIIx—unchanged.

48 hours after inoculation, Wednesday, 8 a. m.
IIIi—unchanged.
IIIi + IIIx—soft curd.
IIIx—loppering.

Acid developed during changes.

Time after inoculation.	0 hrs.	9 hrs.	24 hrs.	33 hrs.	48 hrs.
Culture IIIi...........	15°	15°	15°	15°	15°
Culture IIIi + IIIx...	15°	15°	16°	19°	64°
Culture IIIx.	15°	15°	15°	19°	55°

Bacterial Counts.
In 48 hours.
Culture IIIi—17,100,000.
Culture IIIi + IIIx—2,250,000,000.
Culture IIIx—1,070,000,000.

COMBINATION IIIj AND IIIx.

Dilutions employed for inoculating milk flasks.
Culture IIIj.......... 1 : 10,000
Culture IIIx.......... 1 : 1,000,000

Number of bacteria, IIIj, introduced into milk flask IIIj = 420.
Number of bacteria, IIIx, introduced into milk flask IIIx = 2,110.
Number of bacteria, IIIj and IIIx, introduced into milk flask IIIj + IIIx = 420 + 2,110 = 2,530.

Changes in milk flasks apparent to eye.
Milk flask cultures prepared Monday, 8 a. m.
9 hours after inoculation, Monday, 5 p. m.
IIIj—unchanged.
IIIj + IIIx—unchanged.
IIIx—unchanged.
24 hours after inoculation, Tuesday, 8 a. m.
IIIj—unchanged.
IIIj + IIIx—unchanged.
IIIx—unchanged.
33 hours after inoculation, Tuesday, 5 p. m.
IIIj—litmus slightly reduced.
IIIj + IIIx—litmus reduced.
IIIx—no change.
48 hours after inoculation, Wednesday, 8 a. m.
IIIj—litmus reduced.
IIIj + IIIx—litmus reduced.
IIIx—no change.
57 hours after inoculation, Wednesday 5 p. m.
IIIj—litmus reddened.
IIIj + IIIx—litmus reduced; on point of curdling.
IIIx—no change.

Acid developed during changes.

Time after inoculation..............	0 hrs.	9 hrs.	24 hrs.	33 hrs.	38 hrs.	57 hrs.	72 hrs.
Culture IIIj.....	21°	21°	21°	25°	26°	30°	55°
Culture IIIj + IIIx..............	21°	21°	21°	26°	26°	43°	63°
Culture IIIx....	21°	21°	21°	23°	21°	21°	21°

Bacterial Counts.
In 57 hours.
Culture IIIj—346,000,000.
Culture IIIj + IIIx—1,910,000,000.
Culture IIIx—171,000,000.

COMBINATION IIIk AND IIIx.

Dilutions employed for inoculating milk flasks.
Culture IIIk......... 1 : 10,000
Culture IIIx......... 1 : 1,000,000

Number of bacteria, IIIk, introduced into milk flask IIIk = 78,800.
Number of bacteria, IIIx, introduced into milk flask IIIx = 2,310.
Number of bacteria, IIIk and IIIx, introduced into milk flask IIIk + IIIx = 78,800 + 2,310 = 81,110.

Changes in milk flasks apparent to eye.
Milk flask cultures prepared Wednesday, 4 p. m.
16 hours after inoculation, Thursday, 8 a. m.
IIIk—no change.
IIIk + IIIx—no change.
IIIx—no change.
25 hours after inoculation, Thursday, 5 p. m.
IIIk—no change.
IIIk + IIIx—no change.
IIIx—no change.
40 hours after inoculation, Friday, 8 a. m.
IIIk—litmus slightly reduced.
IIIk + IIIx—soft curd.
IIIx—soft curd.

Acid developed during changes.

Time after inoculation.	0 hrs.	16 hrs.	25 hrs.	40 hrs.
Culture IIIk	18°	18°	18°	23°
Culture IIIk + IIIx	18°	18°	18°	64°
Culture IIIx	18°	17°	17°	57°

Bacterial Counts.
In 40 hours.
Culture IIIk—187,000,000.
Culture IIIk + IIIx—2,270,000,000.
Culture IIIx—2,280,000,000.

Culture.	No. bacteria introduced in culture.[4]	No. bacteria when changed.[3]	Acidity[3] when changed.	Culture appearance when changed.
IIIa[2]	115	157,000,000	16°	no change.
IIIa + IIIx[1]	2,355	857,000,000	37°	litmus nearly reduced.
IIIx	2,240	194,000,000	21°	litmus slightly reduced.
IIIb[2]	7,670	208,000,000	14°	no change.
IIIb + IIIx	10,330	2,500,000,000	71°	soft curd.
IIIx	2,660	222,000,000	20°	no change.
IIIc[2]	55,800	82,300,000d	16°b	no change. c
IIIc + IIIx	57,830	312,000,000a	71°	firm curd.
IIIx.	2,030	116,000,000	61°	soft curd.
IIIe	8,810	1,030,000	17°	no change.
IIIe + IIIx	11,220	2,230,000,000	56°	litmus reduced; loppering.
IIIx	2,410	2,410,000,000	61°	slightly loppering.
IIIf	160,000	2,130,000,000	44°	litmus red.
IIIf + IIIx	160,018	5,800,000,000	61°	soft curd.
IIIx	18	1,100,000,000	69°	soft curd.
IIIg	10,800	1,400,000,000	28°	litmus slightly reduced; ropy.
IIIg + IIIx	13,150	2,300,000,000	61°	litmus reduced; slimy.
IIIx	2,350	1,500,000,000	42°	litmus reduced.
IIIh	898	127,000,000	14°	litmus slightly reduced.
IIIh + IIIx	4,698	1,300,000,000	37°	litmus wholly reduced.
IIIx	3,800	1,700,000,000	52°	red; loppering.
IIIi	134	17,100,000	15°	unchanged.
IIIi + IIIx	3,204	2,250,000,000	64°	soft curd.
IIIx	3,070	1,070,000,000	55°	loppering.
IIIj	420	346,000,000	30°	litmus appearing red.
IIIj + IIIx	2,530	1,910,000,000	43°	litmus reduced; point of curd.
IIIx	2,110	171,000,000	21°	no change.
IIIk	78,800	187,000,000	23°	litmus silghtly reduced.
IIIk + IIIx	81,110	2,270,000,000	64°	soft curd.
IIIx	2,310	2,280,000,000	57°	soft curd.

(a, in 31 hrs.) (b, in 45½ hrs.) (c, in 45½ hrs.) (d, in 24 hrs.), instead of 47 hrs.

[1]Constant letter representing the lactic micro-organisms.
[2]Variable letters, a, b, c, etc., the associate micro-organisms.
[3]Counts and acidities made at the same time unless otherwise designated.
[4]The column indicating the number of bacteria introduced refers to the total number introduced into the flask containing 100 c. cm. of milk.

MICRO-ORGANISMS IN SAMPLE III.

IIIa.

Morphology. Bacillus.
Size—average diameter, .8 microns; length, 1.6 microns to 2.4 microns.
Motility—non-motile.
Staining—stains readily.
Gelatin Colony.
Round; border smooth and entire, pulvinate.
Gelatin Stab.
Filiform.
Agar.
Glistening, opaque.
Bouillon.
Turbid, with sediment.
Potato.
Black.
Milk.
Digested somewhat (?) See also combination IIIa and IIIx.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). None noted.
Proteolysis.
Gelatin is not liquefied.
Biochemical tests.
No indol, hydrogen sulphide, or ammonia. Nitrates are not reduced.
Chromogenesis.
No pigment.

IIIb.

Morphology. Bacillus.
Size—average diameter, 1 micron; length, 1.2 microns to 2 microns.
Motility—motile.
Staining—stains readily.
Gelatin Colony.
Filamentous and floccose.
Gelatin Stab.
Filiform.
Agar.
Glistening, opaque, rugose.
Bouillon.
Turbid with sediment.
Milk.
Loppered somewhat. See also chart combination IIIb and IIIx.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). None noted.
Proteolysis.
Gelatin not liquefied.
Biochemical tests.
No indol, hydrogen sulphide, or ammonia. Nitrates not reduced.
Chromogenesis.
No pigment.

IIIc.

Morphology. Bacillus.
Size—average diameter, .5 microns; length, ·1 micron to 1.6 microns.
Motility—motile.
Staining—stains readily.
Gelatin Colony.
Round, coarsely granular, undulate.
Gelatin Stab.
Filiform, becoming stratiform.
Agar.
Glistening, opalescent.
Bouillon.
Turbid with sediment and scum.
Milk.
Seems to lopper and digest somewhat. Also see chart combination IIIc and IIIx
Fermentation of Sugars (Dextrose, Lactose, Saccharose). None noted.
Proteolysis.
Gelatin liquefied. Casein partly digested.

Biochemical tests.
No indol, or hydrogen sulphide. A trace of ammonia. Nitrates not reduced.
Chromogenesis.
No pigment.

IIIe.

Morphology. Bacillus.
Size—average diameter, .8 microns; length, .96 to 1.6 microns.
Motility—no motion.
Staining—stains readily.
Gelatin Colony.
Round, smooth and entire; border pulvinate.
Gelatin Stab.
Filiform, growing in a thick film over surface.
Agar.
Glistening, opaque, raised.
Bouillon.
Turbid with sediment.
Milk.
Loppering, with some digestion. See chart combination IIIe and IIIx.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). No fermentation of sugars.
Proteolysis.
Gelatin not liquefied.
Biochemical tests.
Traces of indol. No hydrogen sulphide, or ammonia. Nitrates not reduced.
Chromogenesis.
Pigment yellow.

IIIf.

Morphology. Bacillus.
Size—average diameter, .7 microns; length, 1.2 microns to 1.6 microns.
Motility—no motion.
Staining—stains readily.
Gelatin Colony.
Raised, border entire, punctiform.
Gelatin Stab.
Saccate.
Agar.
Dull, opaque.
Bouillon.
Turbid, with sediment.
Milk.
Loppered and some digestion. Also see chart combination IIIf and IIIx.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). All fermented.
Proteolysis.
Gelatin liquefied. Casein digested.
Biochemical tests.
Indol produced. No hydrogen sulphide, or ammonia. Nitrates are reduced.
Chromogenesis.
No pigment.

IIIg.

Morphology. Bacillus.
Size—average diameter, .8 microns; length, 1 micron.
Motility—non-motile.
Staining—stains readily.
Gelatin Colony.
Round, amorphous, smooth and glistening, convex.
Gelatin Stab.
Filiform
Agar.
Glistening, opaque.
Bouillon.
Turbid, with sediment.
Milk.
Ropy and digested. See chart combination IIIg and IIIx.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). All fermented.

Proteolysis.
Gelatin not liquefied.
Biochemical tests.
Indol, trace. No hydrogen sulphide, or ammonia. Nitrates reduced.
Chromogenesis.
No pigment.

IIIh.

Morphology. Bacillus.
Size—average diameter, .9 microns; length, 1 to 1.8 microns.
Motility—non-motile.
Staining—stains readily.
Gelatin Colony.
Round, raised, finely granular, lightly undulate.
Gelatin Stab.
Filiform, tuberculate, surface rhizoid.
Agar.
Glistening, opaque.
Bouillon.
Turbid with sediment and scum.
Milk.
Slimy. Also see chart combination IIIh and IIIx.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). None noted.
Proteolysis.
Gelatin not liquefied. No change in casein apparent.
Biochemical tests.
No indol, hydrogen sulphide, or ammonia. Nitrates are not reduced.
Chromogenesis.
No pigment.

IIIi.

Morphology. Bacillus.
Size—average diameter, .8 microns; length, 1 micron to 1.2 microns.
Motility—no motion.
Staining—stains readily.
Gelatin Colony.
Undulate, transparent.
Gelatin Stab.
Filiform, becoming villous and rhizoid.
Agar.
Glistening, opaque.
Bouillon.
Turbid with sediment.
Milk.
Loppered. Also see chart combination IIIi and IIIx.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). None noted.
Proteolysis.
Gelatin not liquefied. Casein apparently not acted upon.
Biochemical tests.
No indol, hydrogen sulphide, or ammonia. Nitrates not reduced.
Chromogenesis.
No pigment.

IIIj.

Morphology. Bacillus.
Size—average diameter, .4 microns; length, .6 to 1 micron.
Motility—no motion.
Staining—Readily stained.
Gelatin Colony.
Coarsely granular, irregular, raised.
Gelatin Stab.
Filiform, villous.
Agar.
Dull, opaque.
Bouillon.
Turbid with sediment and scum.
Milk.
See chart combination IIIj and IIIx.

Fermentation of Sugars (Dextrose, Lactose, Saccharose). None noted.
Proteolysis.
No liquefaction of gelatin.
Biochemical tests.
No indol, hydrogen sulphide, or ammonia present. Nitrates not reduced.
Chromogenesis.
No pigment.

IIIk.

Morphology. Micrococcus.
Size—average diameter, .4 microns.
Motility—no motion.
Staining—stains readily.
Gelatin Colony.
Irregular, smooth, coarsely granular.
Gelatin Stab.
Crateriform, becoming saccate.
Agar.
Dull, opaque.
Bouillon.
Turbid with sediment.
Milk.
Loppers quickly. See chart combination IIIk and IIIx.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). None noted.
Proteolysis.
Liquefaction of gelatin. Casein not determined.
Biochemical tests.
Indol present. No hydrogen sulphide, or ammonia. Nitrates reduced.
Chromogenesis.
Orange.

IIIx.

Morphology. Bacillus.
Size—average diameter, .6 microns; length, 1 micron.
Motility—no motion.
Staining—readily stained.
Gelatin Colony.
Slightly raised, reticulate, opalescent.
Gelatin Stab.
Filiform.
Agar.
Dull, opalescent.
Bouillon.
Turbid with sediment.
Milk.
Firm curd. Also see chart combination with IIIx.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). None.
Proteolysis.
None.
Biochemical tests.
No indol. No hydrogen sulphide, or ammonia. Nitrates not reduced.
Chromogenesis.
No pigment.

SAMPLE IV.

The milk for this sample was obtained from a dairy in the neighborhood. The milk was fresh morning's milk, was brought to the laboratory, plated, and the acidity tested at 8:00 o'clock a. m.

The milk was handled in the same manner as the other samples.

SAMPLE IV.

Hours after milking.	Acidity of sample.	Total number of bacteria.	Relative number of different types.*																	
			a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	x
0	15°	22,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8½	15°	58,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	15°	188,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	15°	2,090,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48	14°	24,300,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56	16°	478,000,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	20°	789,000,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
80	34°	914,000,000	0	69	0	0	0	0	0	0	0	0	0	0	0	60	0	0	0	670
96	63°	960,000,000	0	9	0	0	0	0	0	0	0	0	0	0	0	45	0	0	0	362
104	77°	2,000,000,000	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1154

*No serious attempt was made to differentiate the types of bacteria in this sample until the 80th hour.

COMBINATION IVb AND IVx.

Dilutions employed for inoculating milk flasks.

Culture IVb.......... 1 : 10,000
Culture IVx.......... 1 : 100,000,000

Number of bacteria, IVb, introduced into milk flask IVb = 114,000.
Number of bacteria, IVx, introduced into milk flask IVx = 23.
Number of bacteria, IVb and IVx, introduced into milk flask IVb + IVx = 114,000 + 23 = 114,023.

Changes in milk flasks apparent to eye.

Milk flask cultures prepared Monday 9 a. m.

7 hours after inoculation, Monday, 4 p. m.
IVb—unchanged.
IVb + IVx—unchanged.
IVx—unchanged.

24 hours after inoculation, Tuesday, 9 a. m.
IVb—unchanged.
IVb + IVx—unchanged.
IVx—unchanged.

31 hours after inoculation, Tuesday, 4 p. m.
IVb—litmus slightly reduced.
IVb + IVx—litmus nearly wholly reduced.
IVx—unchanged.

48 hours after inoculation, Wednesday, 9 a. m.
IVb—no further change.
IVb + IVx—litmus wholly reduced.
IVx—litmus pink.

55 hours after inoculation, Wednesday, 4 p. m.
IVb—no further change.
IVb + IVx—litmus reddened somewhat.
IVx—loppering.

Acid developed during changes.

Time after inoculation.	0 hrs.	7 hrs.	24 hrs.	31 hrs.	48 hrs.	55 hrs.
Culture IVb	14°	14°	14°	17°	17°	15°
Culture IVb + IVx	14°	14°	14°	17°	27°	36°
Culture IVx	14°	14°	14°	14°	28°	50°

Bacterial Counts.
In 55 hours.
Culture IVb—479,000,000.
Culture IVb + IVx—989,000,000.
Culture IVx—1,460,000,000.

COMBINATION IVc AND IVx.

Dilutions employed for inoculating milk flasks.
Culture IVc.......... 1 : 10,000
Culture IVx.......... 1 : 1,000,000

Number of bacteria, IVc, introduced into milk flask IVc =No record.
Number of bacteria, IVx, introduced into milk flask IVx = No record.
Number of bacteria, IVc and IVx, introduced into milk flask IVc + IVx = No record.

Changes in milk flasks apparent to eye.
Milk flask cultures prepared Thursday, 8 a. m.
9 hours after inoculation, Thursday, 5 p. m.
IVc—no change.
IVc + IVx—no change.
IVx—no change.
24 hours after inoculation, Friday, 8 a. m.
IVc—no change.
IVc + IVx—no change.
IVx—no change.
33 hours after inoculation, Friday, 5 p. m.
IVc—no change.
IVc + IVx—litmus almost wholly reduced.
IVx—litmus slightly reduced.
48 hours after inoculation, Saturday, 8 a. m.
IVc—no change.
IVc + IVx—litmus almost wholly reduced.
IVx—litmus becoming red.
57 hours after inoculation, Saturday, 5 p. m.
IVc—litmus slightly reduced.
IVc + IVx—litmus becoming red.
IVx—litmus reddened.

Acid developed during changes.

Time after inoculation.	0 hrs.	9 hrs.	24 hrs.	33 hrs.	48 hrs.	57 hrs.
Culture IVc.............	19°	19°	21°	18°	31°	31°
Culture IVc + IVx.....	19°	21°	22°	22°	27°	43°
Culture IVx............	19°	21°	21°	21°	27°	44°

Bacterial Counts.
In 57 hours.
Culture IVc—5,040,000,000.
Culture IVc + IVx—3,780,000,000.
Culture IVx—1,500,000,000.

COMBINATION IVd AND IVx.

Dilutions employed for inoculating milk flasks.
Culture IVd.......... 1 : 10,000
Culture IVx.......... 1 : 1,000,000

Number of bacteria, IVd, introduced into milk flask IVd = 13,700.
Number of bacteria, IVx, introduced into milk flask IVx = 1,430.
Number of bacteria, IVd and IVx, introduced into milk flask IVd + IVx = 13,700 + 1,430 = 15,130.

Changes in milk flasks apparent to eye.
Milk flask cultures prepared Monday, 8 a. m.
9 hours after inoculation, Monday, 5 p. m.
IVd—no change.
IVd + IVx—no change.
IVx—no change.
24 hours after inoculation, Tuesday, 8 a m.
IVd—no change.
IVd + IVx—no change.
IVx—no change.

32 hours after inoculation, Tuesday, 4 p. m.
IVd—no change.
IVd + IVx—no change.
IVx—no change.
48 hours after inoculation, Wednesday, 8 a. m.
IVd—no change.
IVd + IVx—no change.
IVx—slight reduction of litmus.
72 hours after inoculation, Thursday, 8 a. m.
IVd—no change.
IVd + IVx—no change.
IVx—litmus reddened.

Acid developed during changes.

Time after inoculation.	0 hrs.	9 hrs.	24 hrs.	32 hrs.	48 hrs.	72 hrs.
Culture IVd............	22°	22°	23°	22°	24°	24°
Culture IVd + IVx.....	22°	22°	24°	23°	27°	26°
Culture IVx............	22°	22°	25°	24°	31°	38°

Bacterial Counts.
Destroyed.

COMBINATION IVe AND IVx.

Dilutions employed for inoculating milk flasks.
Culture IVe.......... 1 : 10,000
Culture IVx.......... 1 : 1,000,000

Number of bacteria, IVe, introduced into milk flask IVe = 1.
Number of bacteria, IVx, introduced into milk flask IVx = 375.
Number of bacteria, IVe and IVx, introduced into milk flask IVe + IVx = 1 + 375 = 376.

Changes in milk flasks apparent to eye.
Milk flask cultures prepared Wednesday, 10 a. m.
7 hours after inoculation, Wednesday, 5 p. m.
IVe—no change.
IVe + IVx—no change.
IVx—no change.
24 hours after inoculation, Thursday, 10 a. m.
IVe—no change.
IVe + IVx—no change.
IVx—no change.
31 hours after inoculation, Thursday, 5 p. m.
IVe—no change.
IVe + IVx—no change.
IVx—no change.
49 hours after inoculation, Friday, 11 a. m.
IVe—no change.
IVe + IVx—loppered.
IVx—litmus changed.

Acid developed during changes.

Time after inoculation.	0 hrs.	7 hrs.	24 hrs.	31 hrs.	49 hrs.
Culture IVe...........	18°	18°	18°	18°	34°
Culture IVe + IVx...	18°	18°	18°	20°	70°
Culture IVx...........	18°	18°	18°	20°	49°

Bacterial Counts.
In 49 hours.
Culture IVe—1,070,000,000.
Culture IVe + IVx—2,000,000,000.
Culture IVx—114,000,000.

COMBINATION IVf AND IVx.

Dilutions employed for inoculating milk flasks.
Culture IVf.......... 1 : 1,000,000
Culture IVx.......... 1 : 1,000,000

Number of bacteria, IVf, introduced into milk flask IVf = 1,680.
Number of bacteria, IVx, introduced into milk flask IVx = 450.
Number of bacteria, IVf and IVx, introduced into milk flask IVf + IVx = 1,680 + 450 = 2,130.

Changes in milk flasks apparent to eye.

Milk flask cultures prepared Monday, 7:30 a. m.

9½ hours after inoculation, Monday, 5 p. m.

IVf—no change.

IVf + IVx—no change.

IVx—no change.

24½ hours after inoculation, Tuesday, 8 a. m.

IVf—no change.

IVf + IVx—no change.

IVx—no change.

32½ hours after inoculation, Tuesday, 4 p. m.

IVf—litmus slightly reduced.

IVf + IVx—litmus slightly reduced.

IVx—no change.

49½ hours after inoculation, Wednesday, 9 a. m.

IVf—litmus reddened.

IVf + IVx—litmus reddened and milk loppered.

IVx—litmus slightly reduced.

Acid developed during changes.

Time after inoculation.	0 hrs.	9½ hrs.	24½ hrs.	32½ hrs.	49½ hrs.
Culture IVf..........	18°	18°	18°	27°	49°
Culture IVf + IVx....	18°	18°	20°	29°	57°
Culture IVx..........	18°	18°	18°	19°	28°

Bacterial Counts.

In 32½ hours.

Culture IVf—368,000,000.

Culture IVf + IVx—357,000,000.

Culture IVx—26,000,000.

COMBINATION IVg AND IVx.

Dilutions employed for inoculating milk flasks.

Culture IVg.......... 1 : 10,000

Culture IVx.......... 1 : 1,000,000

Number of bacteria, IVg, introduced into milk flask IVg = 3,270.

Number of bacteria, IVx, introduced into milk flask IVx = 2,300.

Number of bacteria, IVg and IVx, introduced into milk flask IVg + IVx = 3,270 + 2,300 = 5,570.

Changes in milk flasks apparent to eye.

Milk flask cultures prepared Monday, 9 a. m.

8 hours after inoculation, Monday, 5 p. m.

IVg—unchanged.

IVg + IVx—unchanged.

IVx—unchanged.

24 hours after inoculation, Tuesday, 9 a. m.

IVg—unchanged.

IVg + IVx—unchanged.

IVx—unchanged.

32 hours after inoculation, Tuesday, 5 p. m.

IVg—unchanged.

IVg + IVx—litmus mostly reduced.

IVx—litmus slightly reduced.

47 hours after inoculation, Wednesday, 8 a. m.

IVg—unchanged.

IVg + IVx—loppered.

IVx—loppered.

Acid developed during changes.

Time after inoculation.	0 hrs.	8 hrs.	24 hrs.	32 hrs.	47 hrs.
Culture IVg..........	18°	18°	18°	19°	18°
Culture IVg + IVx...	18°	18°	18°	25°	66°
Culture IVx..........	18°	18°	18°	22°	70°

Bacterial Counts.

In 47 hours.

Culture IVg—1,000,000,000.

Culture IVg + IVx—3,000,000,000.

Culture IVx—1,000,000,000.

COMBINATION IVh AND IVx.

Dilutions employed for inoculating milk flasks.

Culture IVh.......... 1 : 1,000,000
Culture IVx.......... 1 : 1,000,000

Number of bacteria, IVh, introduced into milk flask IVh = 1,520.
Number of bacteria, IVx, introduced into milk flask IVx = 338.
Number of bacteria, IVh and IVx, introduced into milk flask IVh + IVx = 1,520 + 338 = 1,858.

Changes in milk flasks apparent to eye.

Milk flask cultures prepared Monday, 8 a. m.
8 hours after inoculation, Monday, 4 p. m.
IVh—no change.
IVh + IVx—no change.
IVx—no change.
24 hours after inoculation, Tuesday, 8 a. m.
IVh—no change.
IVh + IVx—no change.
IVx—no change.
32 hours after inoculation, Tuesday, 4 p. m.
IVh—no change.
IVh + IVx—no change.
IVx—no change.
48 hours after inoculation, Wednesday, 8 a. m.
IVh—no change
IVh + IVx—litmus changing to red.
IVx—litmus reddened.
56 hours after inoculation, Wednesday, 4 p. m.
IVh—no change.
IVh + IVx—loppered.
IVx—litmus reddened.

Acid developed during changes.

Time after inoculation.	0 hrs.	8 hrs.	24 hrs.	32 hrs.	48 hrs.	56 hrs.
Culture IVh.............	14°	14°	14°	14°	14°	15°
Culture IVh + IVx.....	14°	14°	14°	15°	25°	56°
Culture IVx.............	14°	14°	14°	15°	30°	42°

Bacterial Counts.

In 56 hours.
Culture IVh—723,000,000.
Culture IVh + IVx—968,000,000.
Culture IVx—604,000,000.

COMBINATION IVi AND IVx.

Dilutions employed for inoculating milk flasks.

Culture IVi............ 1 : 1,000,000
Culture IVx............ 1 : 1,000,000

Number of bacteria, IVi, introduced into milk flask IVi = 74.
Number of bacteria, IVx, introduced into milk flask IVx = 1,560.
Number of bacteria, IVi and IVx, introduced into milk flask IVi + IVx = 74 + 1,560 = 1,634.

Changes in milk flasks apparent to eye.

Milk flask cultures prepared Wednesday, 2 p. m.
18 hours after inoculation, Thursday, 8 a. m.
IVi—unchanged.
IVi + IVx = unchanged.
IVx—unchanged.
27 hours after inoculation, Thursday, 5 p. m.
IVi—unchanged.
IVi + IVx—unchanged.
IVx—unchanged.
43 hours after inoculation, Friday, 9 a. m.
IVi—unchanged.
IVi + IVx—loppered.
IVx—loppered.

Acid developed during changes.

Time after inoculation.	0 hrs.	18 hrs.	27 hrs.	43 hrs.
Culture IVi	18°	18°	18°	22°
Culture IVi + IVx	18°	18°	18°	68°
Culture IVx	18°	18°	18°	60°

Bacterial Counts.

In 43 hours.

Culture IVi—306,000,000.
Culture IVi + IVx—1,200,000,000.
Culture IVx—1,000,000,000.

COMBINATION IVj AND IVx.

Dilutions employed for inoculating milk flasks.

Culture IVj.......... 1 : 1,000,000
Culture IVx.......... 1 : 1,000,000

Number of bacteria, IVj, introduced into milk flask IVj = 592.
Number of bacteria, IVx, introduced into milk flask IVx = 610.
Number of bacteria, IVj and IVx, introduced into milk flask IVj + IVx = 592 + 610 = 1,202.

Changes in milk flasks apparent to eye.

Milk flask cultures prepared Wednesday, 9 a. m.

7 hours after inoculation, Wednesday, 5 p. m.
IVj—no change.
IVj + IVx—no change.
IVx—no change.

24 hours after inoculation, Thursday, 9 a. m.
IVj—no change.
IVj + IVx—no change.
IVx—no change.

31 hours after inoculation, Thursday, 5 p. m.
IVj—no change.
IVj + IVx—litmus nearly wholly reduced.
IVx—no change.

47 hours after inoculation, Friday, 8 a. m.
IVj—no change.
IVj + IVx—litmus wholly reduced.
IVx—no change.

52½ hours after inoculation, Friday, 1:30 p. m.
IVj—no change.
IVj + IVx—slimy curd.
IVx—litmus red.

Acid developed during changes.

Time after inoculation.	0 hrs.	7 hrs.	24 hrs.	31 hrs.	47 hrs.	52½ hrs.
Culture IVj	15°	15°	14°	15°	15°	15°
Culture IVj + IVx	15°	15°	15°	15°	36°	44°
Culture IVx	15°	15°	16°	15°	17°	22°

Bacterial Counts.

In 52½ hours.

Culture IVj—2,750,000,000.
Culture IVj + IVx—2,350,000,000.
Culture IVx—211,000,000.

COMBINATION IVm AND IVx.

Dilutions employed for inoculating milk flasks.

Culture IVm.......... 1 : 10,000
Culture IVx.......... 1 : 1,000,000

Number of bacteria, IVm, introduced into milk flask IVm = 74,700.
Number of bacteria, IVx, introduced into milk flask IVx = 2,280.
Number of bacteria, IVm and IVx, introduced into milk flask IVm + IVx = 74,700 + 2,280 = 76,980.

Changes in milk flasks apparent to eye.

Milk flask cultures prepared Monday, 9 a. m.

8 hours after inoculation, Monday, 5 p. m.
IVm—unchanged.
IVm + IVx—unchanged.
IVx—unchanged.

24 hours after inoculation, Tuesday, 9 a. m.
IVm—unchanged.
IVm + IVx—unchanged.
IVx—unchanged.

32 hours after inoculation, Tuesday, 5 p. m.
IVm—litmus slightly reddened.
IVm + IVx—litmus slightly reddened.
IVx—unchanged.

48 hours after inoculation, Wednesday, 9 a. m.
IVm—litmus reddened.
IVm + IVx—litmus reddened.
IVx—unchanged.

56 hours after inoculation, Wednesday, 5 p. m.
IVm—litmus slightly reddened.
IVm + IVx—loppered.
IVx—litmus slightly reduced.

Acid developed during changes.

Time after inoculation.	0 hrs.	8 hrs.	24 hrs.	32 hrs.	48 hrs.	56 hrs.
Culture IVm............	18°	18°	21°	36°	42°	49°
Culture IVm + IVx.....	18°	18°	20°	31°	47°	58°
Culture IVx............	18°	18°	18°	20°	22°	26°

Bacterial Counts.

In 56 hours.
Culture IVm—2,300,000,000.
Culture IVm + IVx—1,800,000,000.
Culture IVx—360,000,000.

COMBINATION IVn AND IVx.

Dilutions employed for inoculating milk flasks.

Culture IVn......... 1 : 10,000
Culture IVx......... 1 : 1,000,000

Number of bacteria, IVn, introduced into milk flask IVn = 52,600.
Number of bacteria, IVx, introduced into milk flask IVx = 1,520.
Number of bacteria, IVn and IVx, introduced into milk flask IVn + IVx = 52,600 + 1520 = 54,120.

Changes in milk flasks apparent to eye.

Milk flask cultures prepared Monday, 8 a. m.

9 hours after inoculation, Monday, 5 p. m.
IVn—unchanged.
IVn + IVx—unchanged.
IVx—unchanged.

24 hours after inoculation, Tuesday, 8 a. m.
IVn—unchanged.
IVn + IVx—unchanged.
IVx—unchanged.

33 hours after inoculation, Tuesday, 5 p. m.
IVn—litmus slightly reddened.
IVn + IVx—litmus reduced.
IVx—litmus slightly reduced.

48 hours after inoculation, Wednesday, 8 a. m.
IVn—litmus reddened.
IVn + IVx—loppered.
IVx—loppered.

Acid developed during changes.

Time after inoculation.	0 hrs.	9 hrs.	24 hrs.	33 hrs.	48 hrs.
Culture IVn..........	22°	25°	28°	30°	64°
Culture IVn + IVx...	22°	25°	28°	38°	72°
Culture IVx..........	22°	25°	28°	32°	—

Bacterial Counts.

In 48 hours.

Culture IVn—295,000,000.
Culture IVn + IVx—600,000,000.
Culture IVx—

COMBINATION IVo AND IVx.

Dilutions employed for inoculating milk flasks.

Culture IVo......... 1 : 1,000,000
Culture IVx......... 1 : 1,000,000

Number of bacteria, IVo, introduced into milk flask IVo = 2,860.
Number of bacteria, IVx, introduced into milk flask IVx = 3,490.
Number of bacteria, IVo and IVx, introduced into milk flask IVo + IVx = 2,860 + 3,490 = 6,350.

Changes in milk flasks apparent to eye.

Milk flask cultures prepared Wednesday, 2 p. m.

18 hours after inoculation, Thursday, 8 a. m.
IVo—unchanged.
IVo + IVx—unchanged.
IVx—unchanged.

27 hours after inoculation, Thursday, 5 p. m.
IVo—unchanged.
IVo + IVx—litmus slightly red.
IVx—unchanged.

42 hours after inoculation, Friday, 8 a. m.
IVo—litmus slightly reddened.
IVo + Vx—loppered.
IVx—loppered.

Acid developed during changes.

Time after inoculation.	0 hrs.	16 hrs.	27 hrs.	42 hrs.
Culture IVo....................	20°	20°	20°	33°
Culture IVo + IVx............	20°	20°	22°	78°
Culture IVx....................	20°	20°	21°	66°

Bacterial Counts.

In 42 hours.

Culture IVo—450,000,000.
Culture IVo + IVx—5,090,000,000.
Culture IVx—1,830,000,000.

COMBINATION IVp AND IVx.

Dilutions employed for inoculating milk flasks.

Culture IVp.......... 1 : 1,000,000
Culture IVx.......... 1 : 1,000,000

Number of bacteria, IVp, introduced into milk flask IVp = 6.
Number of bacteria, IVx, introduced into milk flask IVx = 1,800.
Number of bacteria, IVp + IVx, introduced into milk flask IVp + IVx = 6 + 1,800 = 1,806.

Changes in milk flasks apparent to eye.

Milk flask cultures prepared Monday, 8 a. m.

9 hours after inoculation, Monday, 5 p. m.
IVp—unchanged.
IVp + IVx—unchanged.
IVx—unchanged.

24 hours after inoculation. Tuesday, 8 a. m.
IVp—litmus slightly reduced.
IVp + IVx—litmus slightly reduced.
IVx—unchanged.

33 hours after inoculation, Tuesday, 5 p. m.
IVp—litmus reddened and curded.
IVp + IVx—litmus curded.
IVx—litmus slightly reddened.

Acid developed during changes.

Time after inoculation.	0 hrs.	9 hrs.	24 hrs.	33 hrs.
Culture IVp....................	19°	19°	27°	58°
Culture IVp + IVx.............	19°	19°	26°	66°
Culture IVx....................	19°	19°	23°	40°

Bacterial Counts.
In 33 hours.
Culture IVp—1,340,000,000.
Culture IVp + IVx—1,380,000,000.
Culture IVx—166,000,000 at 24 hours.

COMBINATION IVq AND IVx.

Dilutions employed for inoculating milk flasks.
Culture IVq.......... 1 : 1,000,000
Culture IVx.......... 1 : 1,000,000

Number of bacteria, IVq, introduced into milk flask IVq = 7.
Number of bacteria, IVx, introduced into milk flask IVx = 1,260.
Number of bacteria, IVq and IVx, introduced into milk flask IVq + IVx = 7 + 1,260 = 1,237.

Changes in milk flasks apparent to eye.
Milk flask cultures prepared Wednesday, 8 a. m.
9 hours after inoculation, Wednesday, 5 p. m.
IVq—unchanged.
IVq + IVx—unchanged.
IVx—unchanged.
24 hours after inoculation, Thursday, 8 a. m.
IVq—unchanged.
IVq + IVx—unchanged.
IVx—unchanged.
33 hours after inoculation, Thursday, 5 p. m.
IVq—litmus slightly reduced.
IVq + IVx—litmus nearly wholly reduced.
IVx—litmus slightly reduced.
48 hours after inoculation, Friday, 8 a. m.
IVq—loppered.
IVq + IVx—loppered.
IVx—loppered.

Acid developed during changes.

Time after inoculation.	0 hrs.	9 hrs.	24 hrs.	33 hrs.	48 hrs.
Culture IVq..........	19°	19°	21°	30°	96°
Culture IVq +IVx....	19°	19°	21°	36°	99°
Culture IVx..........	19°	19°	23°	32°	96°

Bacterial Counts.
In 48 hours.
Culture IVq—1,670,000,000.
Culture IVq + IVx—1,380,000,000.
Culture IVx—1,750,000,000.

Culture.	No. bacteria[4] introduced in culture.	No. bacteria[3] when changed.	Acidity[3] when changed.	Culture appearance when changed.
IVb[2]	114,000	479,000,000	15°	no further change.
IVb + IVx[1]	114,023	989,000,000	36°	litmus reddened somewhat.
IVx	23	1,460,000,000	50°	loppering.
IVc[2]	....	5,040,000,000	31°	litmus slightly reduced.
IVc + IVx	....	3,780,000,000	43°	litmus becoming red.
IVx	....	1,500,000,000	44°	litmus reddened.
IVd	13,700	....	24°	no change.
IVd + IVx	15,130	....	26°	no change.
IVx	1,430	....	38°	litmus reddened.
IVe	1	1,070,000,000	34°	no change.
IVe + IVx	376	2,000,000,000	70°	loppered.
IVx	375	114,000,000	49°	litmus changed.
IVf	1,680	368,000,000*	49°	litmus reddened.
IVf + IVx	2,130	357,000,000	57°	litmus reddened.
IVx	450	26,000,000	28°	litmus slightly reduced.
IVg	3,270	1,000,000,000	18°	unchanged.
IVg + IVx	5,570	3,000,000,000	66°	loppered.
IVx	2,300	1,000,000,000	70°	loppered.
IVh	1,520	723,000,000	15°	no change.
IVh + IVx	1,858	968,000,000	56°	loppered.
IVx	338	604,000,000	42°	litmus reddened.
IVi	74	306,000,000	22°	unchanged.
IVi + IVx	1,634	1,200,000,000	68°	loppered.
IVx	1,560	1,000,000,000	60°	loppered.
IVj	592	2,750,000,000	15°	no change.
IVj + IVx	1,202	2,350,000,000	44°	slimy curd.
IVx	610	211,000,000	22°	litmus red.
IVm	74,700	2,300,000,000	49°	litmus slightly reddened.
IVm + IVx	76,980	1,800,000,000	58°	loppered.
IVx	2,280	360,000,000	26°	litmus slightly reduced.
IVn	52,600	295,000,000	64°	litmus reddened.
IVn + IVx	54,120	600,000,000	72°	loppered.
IVx	1,520	....	....	loppered.
IVo	2,860	450,000,000	33°	litmus slightly reddened.
IVo + IVx	6,350	5,090,000,000	78°	loppered.
IVx	3,490	1,830,000,000	86°	loppered.
IVp	6	1,340,000,000	58°	litmus reddened and curded.
IVp + IVx	1,806	1,380,000,000	66°	litmus curded.
IVx	1,800	166,000,000	40°	litmus slightly reddened.
IVq	7	1,670,000,000	96°	loppered.
IVq + IVx	1,267	1,380,000,000	99°	loppered.
IVx	1,260	1,750,000,000	96°	loppered.

*In 32½ hours.
[1]Constant letter represents the lactic micro-organism.
[2]Variable letters, a, b, c, etc., the associate micro-organism.
[3]Counts and acidities made at the same time unless otherwise designated.
[4]The column indicating the number of bacteria introduced, refers to the total number introduced into the flask containing 100 c. cm. of milk.

MICRO-ORGANISMS OF SAMPLE IV.

IVb.

Morphology. Bacillus.
Size—average diameter, .7 microns; length, 1.2 to 1.6 microns.
Motility—motile.
Staining—stains readily.
Gelatin Colony.
Round, convex, entire.
Gelatin Stab.
Beaded.
Agar.
Glistening, opalescent.
Bouillon.
Turbid, with sediment and scum.
Potato.
Moist, discolored.
Milk.
Litmus reduced. Also see chart combination IVb and IVx.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). None.
Proteolysis.
None.
Biochemical tests.
Indol produced. No hydrogen sulphide, or ammonia. Nitrates reduced.
Chromogenesis.
Yellow.

IVc.

Morphology. Bacillus.
Size—average diameter, .7 microns; length, .8 microns to 1.8 microns.
Motility—not motile.
Staining—stains readily.
Gelatin Colony.
Round, pulvinate, entire, granular.
Gelatin Stab.
Filiform.
Agar.
Dull, opalescent.
Bouillon.
Turbid with sediment.
Potato.
Discolored, dry and scant growth.
Milk.
Litmus reduced. Also see chart combination IVc and IVx.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). None noted.
Proteolysis.
None.
Biochemical test.
No indol, or hydrogen sulphide. Ammonia present. Nitrates are reduced.
Chromogenesis.
No pigment.

IVd.

Morphology. Streptococcus.
Size—average diameter, 1.3 microns.
Motility—No motion.
Staining—difficultly stained.
Gelatin Colony.
Round, pulvinate, entire.
Gelatin Stab.
Tuberculate.
Agar.
Dull, opalescent.
Bouillon.
Turbid, with sediment.
Potato.
No growth.

Milk.
Firm curd. Also see chart combination IVd and IVx.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). All positive.
Proteolysis.
None.
Biochemical tests.
Indol present. No hydrogen sulphide, or ammonia. Nitrates reduced.
Chromogenesis.
No pigment.

IVe.

Morphology. Bacillus.
Size—average diameter, .7 microns; length 1.2 to 1.6 microns.
Motility—motile.
Staining—stains readily.
Gelatin Colony.
Round, convex, entire, reticulate.
Gelatin Stab.
Filiform, becoming crateriform.
Agar.
Glistening, opaque.
Bouillon.
Turbid, with scum and sediment.
Potato.
Moist, abundant growth.
Milk.
Loppered; gas production. See chart combination IVe and IVx.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). All fermented.
Proteolysis.
Gelatin liquefied. Casein not noted.
Biochemical tests.
No indol, hydrogen sulphide, or ammonia. Nitrates reduced.
Chromogenesis.
No pigment.

IVf.

Morphology. Bacillus.
Size—average diameter, .4 microns; length, 1.2 to 1.6 microns.
Motility—no motion.
Staining—stains readily.
Gelatin Colony.
Round and undefined.
Gelatin Stab.
Not noted.
Agar.
Glistening, opaque.
Bouillon.
Turbid, with scum and sediment.
Potato.
Moist, abundant growth. Discolored.
Milk.
Loppered; gas production. Also see chart combination IVf and IVx.
Fermentation of Sugars (Dextrose, Lactose and Saccharose). All positive.
Proteolysis.
None noted.
Biochemical tests.
No indol, hydrogen sulphide, or ammonia. Nitrates reduced.
Chromogenesis.
No pigment.

IVg.

Morphology. Bacillus.
Size—average diameter, .5 microns; length, .6 to .8 microns.
Motility—no motion.
Staining—stains readily.
Gelatin Colony.
Round, entire, opalescent.

Gelatin Stab.
Filiform, becoming infundibuliform.
Agar.
Glistening, opaque.
Bouillon.
Turbid, with scum and sediment.
Potato.
Moist, discolored.
Milk.
Digested. Also see chart combination IVg and IVx.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). None.
Proteolysis.
Gelatin liquefied. Casein digested.
Biochemical tests.
No indol, hydrogen sulphide, or ammonia. Nitrates reduced.
Chromogenesis.
No pigment.

IVh.

Morphology. Bacillus.
Size—average diameter, 1 micron; length, 2.2 microns to 4.5 microns.
Motility—motile.
Staining—stains readily.
Gelatin Colony.
Round, entire, finely granular.
Gelatin Stab.
Filiform, becoming crateriform.
Agar.
Glistening, opaque.
Bouillon.
Turbid with sediment.
Potato.
Moist, abundant growth.
Milk.
Litmus changed to green. Also see chart combination IVh and IVx.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). None.
Proteolysis.
Gelatin liquefied. Casein not noted.
Biochemical tests.
No indol, hydrogen sulphide, or ammonia. Nitrates reduced.
Chromogenesis.
Green.

IVi.

Morphology. Bacillus.
Size—Average diameter, .9 microns; length, 2.2 to 3 microns.
Motility—motile.
Staining—stains readily.
Gelatin Colony.
Not noted.
Gelatin Stab.
Infundibuliform.
Agar.
Dull, opaque.
Bouillon.
Turbid, with sediment.
Potato.
Abundant, discolored growth.
Milk.
Loppered, firm curd.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). Dextrose and Saccharose fermented; Lactose not fermented.
Proteolysis.
Gelatin liquefied.
Biochemical tests.
No indol, or ammonia; hydrogen sulphide present. Nitrates are reduced.
Chromogenesis.
No pigment.

IVj.

Morphology. Bacillus.
Size—average diameter, .8 microns; length, 1.5 microns to 2.5 microns.
Motility—positive.
Staining—stains readily.
Gelatin Colony.
Round, grumose, entire.
Gelatin Stab.
Plumose.
Agar.
Glistening, opaque.
Bouillon.
Turbid, with scum and sediment.
Potato.
Milk.
Ropy. Also see chart combination IVj and IVx.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). None.
Proteolysis.
None noted.
Biochemical tests.
No indol, hydrogen sulphide, or ammonia present. Nitrates are reduced.
Chromogenesis.
No pigment.

IVm.

Morphology. Bacillus.
Size—average diameter, 1.2 microns; length 2 microns to 3 microns.
Motility—no motility.
Staining—readily stained.
Gelatin Colony.
Round, granular.
Gelatin Stab.
Filiform and gas bubbles.
Agar.
Glistening, opaque.
Bouillon.
Turbid with sediment.
Potato.
Moist, abundant growth. Potato discolored.
Milk.
Loppered and gas production.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). All fermented.
Proteolysis.
None noted.
Biochemical tests.
No indol, hydrogen sulphide, or ammonia. Nitrates reduced.
Chromogenesis.
No pigment.

IVn.

Morphology. Bacillus.
Size—average diameter, .8 microns; length, 1.4 microns to 2.4 microns.
Motility—no motion.
Staining—stains readily.
Gelatin Colony.
Round, granular, edge villous.
Gelatin Stab.
Filiform, becoming napiform.
Agar.
Glistening, opaque.
Bouillon.
Turbid, with sediment.
Potato.
Negative.
Milk.
Loppered, gas production.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). All positive.

Proteolysis.
Gelatin liquefied.
Biochemical tests.
No indol, hydrogen sulphide, or ammonia present. Nitrates reduced.
Chromogenesis.
No pigment.

IVo.

Morphology. Bacillus.
Size—average diameter, .8 microns to 1 micron; length, 1 micron to 3.5 microns.
Motility—motile.
Staining—stains readily.
Gelatin Colony.
Finely granular.
Gelatin Stab.
Beaded growth with gas.
Agar.
Dull, opalescent.
Bouillon.
Turbid, sediment and scum.
Potato.
Discolored.
Milk.
Curding, gas production.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). All positive.
Proteolysis.
None noted.
Biochemical tests.
No indol, hydrogen sulphide, or ammonia. Nitrates reduced.
Chromogenesis.
No pigment.

IVp.

Morphology. Bacillus.
Size—average diameter, .5 microns; length, 1.6 to 2.4 microns.
Motility—motile.
Staining—stains readily.
Gelatin Colony.
Not noted.
Gelatin Stab.
Filiform, becoming stratiform.
Agar.
Dull, opalescent.
Bouillon.
Turbid with sediment.
Potato.
Moist, abundant growth.
Milk.
Curd. Also see chart combination IVp and IVx.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). Not noted.
Proteolysis.
Gelatin liquefied.
Biochemical tests.
No indol, hydrogen sulphide, or ammonia present. Nitrates reduced.
Chromogenesis.
Green.

IVq.

Morphology. Bacillus.
Size—average diameter, .8 microns; length, 1 to 2 microns.
Motility—motile.
Staining—stains readily.
Gelatin Colony.
Round, grumose, entire.
Gelatin Stab.
Beaded.
Agar.
Dull, opalescent.

Bouillon.
Turbid.
Potato.
Milk.
Curded. Also see chart combination IVq and IVx.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). All fermented.
Proteolysis.
None.
Biochemical tests.
Indol present. No hydrogen sulphide, or ammonia. Nitrates reduced.
Chromogenesis.
No pigment.

IVx.

Morphology. Bacillus.
Size—average diameter, .75 microns; length, 1.5 to 2 microns.
Motility—no motion.
Staining—stains readily.
Gelatin Colony.
Round, grumose, finely granular, irregular.
Gelatin Stab.
Filiform.
Agar.
Dull, opalescent.
Bouillon.
Turbid.
Potato.
Milk.
Curded. Also see chart combinations with IVx.
Fermentation of Sugars (Dextrose, Lactose, Saccharose). All positive.
Proteolysis.
None noted.
Biochemical tests.
Indol positive. Hydrogen sulphide, and ammonia, negative. Nitrates are reduced.
Chromogenesis.
No pigment.

NOTE:—Some doubt may be entertained concerning the lactic nature of IVx on account of its life's history. Its action on milk was characteristic, aside from the gas produced. Because of this and its relation to the souring of the sample it was selected as the lactic germ.

DISCUSSION.

From the preceding tables it will be seen that—

1. The combinations of micro-organisms which facilitate the growth and development of lactic micro-organisms are: Ia, Ie, Ig, Ih, IIe, IIg, IIj, IIIa, IIIb, IIIc, IIIf, IIIg, IIIi, IIIj, IIIk, IVb, IVe, IVf, IVh, IVi, IVj, IVm, IVp, IVq, making a total of twenty-four.

2. The combinations which seem to have no influence on the micro-organisms are: Id, If, IIa, IIb, IIc, IId, IIh, IIi, IIk, IVc, IVg, making a total of eleven.

3. The combinations which seem to retard the development of the lactic micro-organisms, or neutralize the acid produced are: Ib, Ic, IIm, IIIe, IIIh, IVd, IVo, making a total of seven.

By the above grouping the three general consideratons which follow, are presented. All possibilities are thus included. Associate micro-organisms must either—

1. Increase or hasten the action of lactic bacteria, or
2. Have no influence upon lactic bacteria, or
3. Retard or inhibit the action of lactic bacteria.

It is, I believe, desirable to repeat that should the relative number of micro-organisms introduced in the combination be changed, or should the cultures be subjected to different temperatures during the development, the writers are confident that the results as here presented would be materially altered. However, it is assumed that these results may be safely considered as an average.

AT WHICH STAGE OF THE PROCESS IS THE ASSOCIATE INFLUENCE MANIFESTED?

It appears from the illustrations taken from the preceding tables, that in some instances the associate micro-organisms seem to exert an influence at the beginning of the souring process; in some it appears later, even at the end of the process; and, in still others, the influence seems to be felt throughout the process from beginning to end.

The following tables will illustrate the varied influence of the associate micro-organisms.

The associate micro-organism in the first table has evidently carried on its functions early in the process, and later seems to have held in check the lactic micro-organisms.

Time after inoculation.	0 hrs.	7 hrs.	24 hrs.	31 hrs.	48 hrs.	53 hrs.
Culture IIIf	14°	14°	14°	25°	44°	44°
Culture IIIf + IIIx	14°	14°	17°	26°	45°	61°
Culture IIIx	14°	14°	14°	14°	41°	69°

In the next table the influence of the lactic micro-organisms is retarded until the later stages of the process.

Time after inoculation.	0 hrs.	7 hrs.	23 hrs.	31 hrs.	47 hrs.	59 hrs.
Culture IIIb	14°	14°	14°	14°	14°	14°
Culture IIIb + IIIx	14°	14°	14°	14°	17°	71°
Culture IIIx	14°	14°	15°	15°	18°	20°

The third table will illustrate how the associate influence is felt from the beginning, and appears to extend throughout the process.

Time after inoculation.	0 hrs.	24 hrs.	48 hrs.	67 hrs.
Culture Ig	18°	22°	29°	30°
Culture Ig + Ij	18°	33°	39°	46°
Culture Ij	18°	23°	26°	28°

RELATION OF THE NUMBER OF ASSOCIATE AND LACTIC MICRO-ORGANISMS, INTRODUCED INTO THE COMBINED CULTURE, TO THE ACCELERATION OF THE LACTIC MICRO-ORGANISMS.

Doubtless the relative number of bacteria introduced into a flask of milk would have a decided influence upon the results of association, provided the associate micro-organisms would develop as rapidly as the lactic in milk. In work of this character much is dependent upon this feature.

We have not been able to control the number introduced. In all of the work, the only means was to ascertain the number after introduction and accept the results in the light of a weakness of technique. Yet this very weakness, has, in a manner, contributed many sides which would otherwise have been overlooked.

The annexed table will illustrate the significance of numbers to some extent—constant letters, or the last letter of each combination represents the lactic micro-organisms, while the first letter represents the associate micro-organism. Plus indicates that the lactic micro-organism has been accelerated, minus that it has been retarded, plus-minus that no effect has been noticed.

Combination.	Acceleration.	No. of lactic micro-organisms introduced into milk-flask.	Per cent.	No. of associate micro-organisms introduced into milk-flask.	Per cent.
Ia + Ii	+	6	60%	4	40%
Ib + Ii	—	9	31%	20	69%
Ic + Ii	—	3	60%	2	40%
Id + Ii	±	134,000	97%	3,400	3%
Ie + Ii	+	14	96%	348	4%
If + Ii	±	765	64%	435	36%
Ig + Ii	+	48,100	52%	44,800	48%
Ih + Ii	+	22	13%	147	87%
IIa + IIx	±	2,000	78%	540	22%
IIb + IIx	±	127,000	99% +	17	.0001%
IIc + IIx	±	275,000	91%	29,000	9%
IId + IIx	±	1,800	99%	17	1%
IIe + IIx	+	285,000	58%	205,000	42%
IIg + IIx	+	1,820	1%	525,000	99%
IIh + IIx	±	1,880	1%	693,000	99%
IIi + IIx	±	1,630	43%	2,190	57%
IIj + IIx	+	17,300	93%	1,480	7%
IIk + IIx	±	48,000	34%	96,000	66%
IIm + IIx	—	296,000	98%	4,460	2%
IIIa + IIIx	+	2,240	95%	115	5%
IIIb + IIIx	+	2,660	26%	7,770	74%
IIIc + IIIx	+	2,030	4%	55,800	96%
IIIe + IIIx	—	2,410	22%	8,810	78%
IIIf + IIIx	+	18	.0001%	160,000	99% +
IIIg + IIIx	+	2,350	18%	10,800	82%
IIIh + IIIx	—	3,800	75%	898	25%
IIIi + IIIx	+	3,070	95%	134	5%
IIIj + IIIx	+	2,110	83%	420	17%
IIIk + IIIx	+	2,310	3%	78,800	97%
IVb + IVx	+	23	.002%	114,000	99% +
IVc + IVx	±	—	....	—	....
IVd + IVx	—	1,430	10%	13,700	90%
IVe + IVx	+	375	99% +	1	.002%
IVf + IVx	+	450	22%	1,680	78%
IVg + IVx	±	2,300	43%	3,270	57%
IVh + IVx	+	338	18%	1,520	82%
IVi + IVx	+	1,560	95%	74	5%
IVj + IVx	+	610	51%	592	49%
IVm + IVx	+	2,280	2%	74,700	98%
IVn + IVx	—	—	....	—	....
IVo + IVx	—	3,490	55%	2,860	45%
IVp + IVx	+	1,800	99% +	6	.003%
IVq + IVx	+	1,260	99% +	7	.005%

Although the relative number of each micro-organism in a combined culture has much to do with its final outcome, yet the above table will conclusively demonstrate that association is to a greater or less extent independent of such numbers.

The accelerating influence is noticeable when the number of the associate micro-organisms

(1) is much below the number of lactic micro-organisms in the culture.
(2) is much above the number of lactic micro-organisms in the culture.
(3) is about equal to the number of lactic micro-organisms in the culture.

The real significance of the *number value* when two kinds of bacteria are brought together in a combined culture, can only be estimated after prolonged experimentation with this factor as the leader.

THE ASSOCIATIVE INFLUENCE AND THE REACTION OF THE CULTURE.

The associative influence is not confined to any definite reaction of the culture,[1] or to any class of organisms which may be regarded as alkali or acid producers. As an illustration, Culture Ia gives rise to no change in acidity, the milk remains at 18° although the multiplication of the micro-organisms is very rapid, increasing from 4 to 300,000,000 in fifty-three hours.

Culture Ig mounts from 18° acid to 30° in sixty-seven hours, as rapidly as the check lactic culture, and yet the acidity of Ig will not account for the increased acidity of Ig + Ij. Now again, if the acidity of IIj were added to the acidity of IIx in forty-eight hours, perhaps the increased acidity of IIj + IIx over IIx would be understood.

These three possibilities, therefore, exist in accounting for the increased development of the lactic micro-organisms:

First, where the milk does not become acid by the cultivation of the associate germ.

Second, where the milk becomes acid by the growth of the associate micro-organism, but this acidity cannot account for the increased acidity of the combined culture.

Third, where the milk becomes acid by the growth of the associate micro-organisms, and this added acidity may account for the increased acidity of the combined culture.

To support these contentions let us bring together into groups the substantiating facts for each.

GROUP I.

Time after inoculation.	0 hrs.	23½ hrs.	42 hrs.	53 hrs.
Culture Ia	18°	18°	18°	18°
Culture Ia + Ij	18°	18°	24°	69°
Culture Ij	18°	18°	21°	33°

Time after inoculation.	0 hrs.	25 hrs.	41 hrs.	47 hrs.
Culture Ih	16°	16°	16°	16°
Culture Ih + Ij	16°	16°	32°	58°
Culture Ij	16°	16°	16°	17°

Time after inoculation.	0 hrs.	23 hrs.	42 hrs.
Culture IIe	18°	19°	20°
Culture IIe + IIx	18°	19°	56°
Culture IIx	18°	19°	38°

Time after inoculation.	0 hrs.	18 hrs.	42 hrs.	66 hrs.
Culture IIg	21°	20°	20°	21°
Culture IIg + IIx	21°	22°	36°	79°
Culture IIx	21°	22°	31°	83°

Time after inoculation.	0 hrs.	6 hrs.	22 hrs.	54 hrs.	70 hrs.
Culture IIIa	16°	16°	16°	16°	16°
Culture IIIa + IIIx	16°	16°	17°	37°	87°
Culture IIIx	16°	16°	17°	21°	83°

Time after inoculation.	0 hrs.	7 hrs.	23 hrs.	31 hrs.	47 hrs.	59 hrs.
Culture IIIb	14°	14°	15°	15°	16°	14°
Culture IIIb + IIIx	14°	14°	14°	14°	17°	71°
Culture IIIx	14°	14°	15°	15°	17°	71°

Time after inoculation.	0 hrs.	7 hrs.	22 hrs.	31 hrs.	45½ hrs.
Culture IIIc	14°	14°	15°	16°	16°
Culture IIIc + IIIx	14°	14°	15°	18°	71°
Culture IIIx	14°	14°	15°	18°	61°

Time after inoculation.	0 hrs.	9 hrs.	24 hrs.	33 hrs.	48 hrs.
Culture IIIi	15°	15°	15°	15°	15°
Culture IIIi + IIIx	15°	15°	16°	19°	64°
Culture IIIx	15°	15°	15°	19°	55°

Time after inoculation.	0 hrs.	8 hrs.	24 hrs.	32 hrs.	48 hrs.	56 hrs.
Culture IVh	14°	14°	14°	14°	14°	15°
Culture IVh + IVx	14°	14°	14°	15°	25°	56°
Culture IVx	14°	14°	14°	15°	30°	42°

Time after inoculation.	0 hrs.	7 hrs.	24 hrs.	31 hrs.	47 hrs.	52½ hrs.
Culture IVj	15°	15°	14°	15°	15°	15°
Culture IVj + IVx	15°	15°	15°	15°	36°	42°
Culture IVx	15°	15°	16°	15°	17°	22°

Time after inoculation.	0 hrs.	18 hrs.	27 hrs.	43 hrs.
Culture IVl	18°	18°	18°	22°
Culture IVl + IVx	18°	18°	18°	6°

GROUP II.

Time after inoculation.	0 hrs.	23 hrs.	49 hrs.	72 hrs.
Culture Ie	18°	22°	25°	27°
Culture Ie + Ij	18°	27°	35°	42°
Culture Ij	18°	21°	25°	27°

Time after inoculation.	0 hrs.	24 hrs.	48 hrs.	67 hrs.
Culture Ig	18°	22°	29°	30°
Culture Ig + Ij	18°	23°	39°	46°
Culture Ij	18°	23°	26°	28°

Time after inoculation.	0 hrs.	8 hrs.	24 hrs.	33 hrs.	47½ hrs.
Culture IIIg	16°	16°	16°	21°	28°
Culture IIIg + IIIx	16°	16°	17°	25°	61°
Culture IIIx	16°	16°	16°	19°	42°

Time after inoculation.	0 hrs.	9 hrs.	24 hrs.	33 hrs.	48 hrs.	57 hrs.
Culture IIIj	21°	21°	21°	25°	26°	30°
Culture IIIj + IIIx	21°	21°	21°	26°	26°	43°
Culture IIIx	21°	21°	21°	23°	21°	21°

Time after inoculation.	0 hrs.	7 hrs.	24 hrs.	31 hrs.	49 hrs.
Culture IVe	18°	18°	18°	18°	34°
Culture IVe + IVx	18°	18°	18°	20°	70°
Culture IVx	18°	18°	18°	20°	49°

GROUP III.

Time after inoculation.	0 hrs.	24 hrs.	48 hrs.
Culture IIj	21°	23°	30°
Culture IIj + IIx	21°	23°	66°
Culture IIx	21°	21°	58°

Time after inoculation.	0 hrs.	7 hrs.	24 hrs.	31 hrs.	48 hrs.
Culture IIIf	14°	14°	14°	25°	44°
Culture IIIf + IIIx	14°	14°	17°	26°	45°
Culture IIIx	14°	14°	14°	14°	41°

Time after inoculation.	0 hrs.	16 hrs.	25 hrs.	40 hrs.
Culture IIIk	18°	18°	18°	23°
Culture IIIk + IIIx	18°	18°	18°	64°
Culture IIIx	18°	18°	17°	57°

Time after inoculation.	0 hrs.	9½ hrs.	24½ hrs.	32½ hrs.	49½ hrs.
Culture IVf	18°	18°	18°	27°	49°
Culture IVf + IVx	18°	18°	20°	29°	57°
Culture IVx	18°	18°	18°	19°	28°

Time after inoculation.	0 hrs.	8 hrs.	24 hrs.	32 hrs.	48 hrs.	56 hrs.
Culture IVm	18°	18°	21°	36°	42°	49°
Culture IVm + IVx	18°	18°	20°	31°	47°	58°
Culture IVx	18°	18°	18°	20°	22°	26°

Time after inoculation.	0 hrs.	9 hrs.	24 hrs.	33 hrs.
Culture IVp	19°	19°	27°	58°
Culture IVp + IVx	19°	19°	25°	66°
Culture IVx	19°	19°	23°	40°

The bacterial counts and naked eye appearance of cultures may be obtained by reference to data preceding.

THE BACTERIAL INFLUENCE DISCUSSED.

While we have already stated that it is impossible to understand the nature of the substances or agents which influence the growth of lactic micro-organisms, it will be interesting and advantageous to review these investigations in the light of our present knowledge of lactic fermentation.

Before beginning this review, it may be well to enumerate some of the explanations offered as possible for the hastening of lactic souring.

1. Products are formed by the associate bacteria which may either—

(a) Provide a better pabulum for the lactic micro-organisms, or

(b) Neutralize the acid formed by the lactic micro-organisms, as in the case of inorganic bases, and thus stimulate their growth, or

(c) The acid produced by the associate micro-organisms may always account for the added acidity in combinations.

2. The associate bacteria may exert some influence upon the lactic bacteria in their relation to oxygen supply or other environmental conditions.

3. There may be some relationship not at present indicated.

By the work of Euling [1], confirmed by C. Revis and G. A. Payne [2], who claims that the casein in milk exists in the form of a tri-calcium phosphate salt, some idea is obtained as to the real nature of casein in milk. This compound is, however, understood differently by others, for Söldner [3] demonstrated the possibility of casein forming more than one salt with calcium, and that the salt neutral in reaction was the probable form existing in milk. He also believed that the calcium phosphate usually mixed with casein precipitates was not chemical but a mechanical mixture. VanSlyke and Hart [4] have confirmed the main results of Söldner, who, according to their interpretation of his work, must have arrived at this conclusion inferentially [5]. Courant [6] mentions these casein salts of Söldner as tri-calcium (basic) casein and di-calcium casein (neutral). Again, Lehman and Hempel[7] would make milk-casein a combination of calcium casein and calcium phosphate. From the above evidence, it is safe to tentatively conclude that calcium is combined with casein and perhaps this same calcium anchors some acid radical in the formation of a salt.

Besides the combining power possessed by casein for the inorganic constituents of milk, (as calcium and phosphates, and perhaps other elements or radicals,) there is a decided attraction on the part of casein for acids formed in fermentation. This acid-combining property of casein has much to do with the understanding of the nature of milk-souring, although it may be no more significant than that exercised by the inorganic substance.

Hammerstein[8] regarded the union of casein and acid as non-chemical because of its ready response to the action of water. Laxa[9] says that casein combines with lactic acid to form lactates, but that these lactates do not have the definite values ascribed to them by VanSlyke and Hart[10], who claim "When casein or paracasein is treated with an acid in definite quantities, we obtain compounds of definitely characteristic properties." This, however, may mean the same as conveyed by Laxa who appears to convey the idea that casein, under different conditions, is capable of combining with different amounts of acid. This seems to be in accordance with the statement of L. L. VanSlyke and D. D. VanSlyke[11], "Casein takes up acid from dilute solutions. For example, one gram of casein shaken with 100 cc. of N-1,000 hydrochloric acid for three hours, takes from the solution nearly 50% of the acid. The amount of acid thus taken up is not definite and fixed, but varies (a) with the concentration of the acid, (b) with the duration of contact until equilibrium is reached, (c) with the temperature, and (d) with the kind of acid. Some acid is always taken up however small the amount of acid used; but the acid is never completely removed from the solution however large the proportion of casein present."

While there may be some doubt as to the definite combinations of casein and lactic acid, casein and calcium and perhaps phosphate, for our pur-

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[1]Landwirtsch. Versuchs-Stationen Bd. XXXI-5-403 (1885).
[2]Journal of Hygiene, Vol. VII, No. 2, p. 219 (1907).
[3]Landwirtsch. Versuchs-Stationen Bd. XXXV-5-351 (1888).
[4]American Chemical Journal, Vol. 33, p. 464 (1905).
[5]American Chemical Journal, Vol. 33, p. 467 (1905).
[6]Pflugers Arch., 50-109 (1891).
[7]Pflugers Arch., 56-558 (1894).
[8]Jahresbericht der Thierchemie Bd. VII p. 160.
[9]Milchwirtschaftliches Zentralblatt, Bd. I. p. 538 (1905).
[10]Am. Chem. Jour., Vol. XXXIII, p. 494 (1905).
[11]Tech. Bulletin No. 3, N. Y. Agricultural Experiment Station (1906).

pose, quite a clear conception may be gained of the disappearance of traces of lactic acid in the natural souring of milk.

Laxa[1] suggests that the lactic acid first formed combines with inorganic substances of the milk, but also, almost immediately forms a lactate in combination with casein. VanSlyke and Hart[2] says "Where acid is formed in cow's milk, or added to it, the acid first combines with the bases of the inorganic salts of the milk and then with the calcium resulting in the formation of a precipitate which is free casein."

"By further formation or addition of acid, the free casein unites with it, forming a casein salt of the acid, this compound, in the case of lactic acid, being the coagulum familiar in the ordinary souring of milk."

Revis and Payne[3] claim "The compounds of calcium salts and of lactic acid with casein as they occur in milk, do not possess the definite compositions of those that have been formed with casein after its separation from milk, as described by Söldner for lime salts, and Van Slyke and Hart for lactates of casein, but that the proportions of tri-phosphates and lactic acid in combination with the casein are at any moment before the milk coagulates, the result of a sort of equilibrium between the casein and total lactic acid present, and that at the moment of precipitation of the casein, the calcium tri-phosphate has been practically completely eliminated, and the combination with lactic acid has reached a maximum."

This cursory consideration throws some light upon the possible changes taking place during the formation of lactic acid.

There are inorganic salts apparently in loose combination with casein besides the inorganic salts naturally in solution. These may respond to lactic acid in forming neutral lactates untouched by the usual titrating methods, and thus account for the seeming delay in the formation of acid until the lactic micro-organisms have reached a certain number, somewhere in the hundreds of millions per c. cm. With the introduction of the associate element, either the lactic micro-organisms are stimulated by the formation of definite products due to the growth or increase of the associate germs, or possibly, on the other hand, these products liberate or make recognizable earlier in the process, the acid manufactured by the lactic micro-organisms. Both considerations may be applicable, since the increase in acid in the combination does not always seem attributable to the same cause.

There is also in alcohol fermentation a stage, at the beginning or for a period after inoculation, in which the only visible signs of anything transpiring are found in an increase of the yeast content. After fermentation sets in, progress is rapid. At this time when fermentation is most active zymase may be most advantageously extracted by Buchner's method. This does not answer, however, what relation the yeast cells have to fermentation during the period of quiescent growth, and during which very little if any zymase may be detected; the period is short, when no fermentation changes can be detected.

Is it true that enzymes are not manufactured or that fermentative changes do not take place before the micro-organisms foresee the end of their increase in the medium and that any influence or agent which will reduce the time necessary to reach this point, makes the process shorter, whether it is temperature, oxygen supply, reaction, pabulum or the influence of an associate germ? If so, then an associate influence may be nothing more

[1]Milchwirtschaft Zentralblatt, Bd. I. p., 358.
[2]Am. Jour., Vol. 33, p. 495 (1905).
[3]Journal of Hygiene, Vol. VII, No. 2, p. 231 (1907).

than facilitation of the lactic micro-organisms in growth and in the production of its enzyme.

The gradual increase of lactic bacteria would support this view. Inasmuch as micro-organisms producing acid and alkali are both capable of this incentive action, it follows that in all cases, it can not be the neutralization of acid formed; nor since in some cases the acidity increases and in some the alkalinity, can it be due to any stimulating action upon the lactic bacteria of an increased acid reaction of the nutrient medium. All workers are aware that the casein in milk does neutralize the acid formed in such a manner as to render possible the continued growth of lactic bacteria within limitations, but this would in no way elucidate the influence at work when the micro-organisms are cultivated together. Thus it is apparent that the acid or alkali added by the associate germ cannot account for the influences.

In all cases it cannot be the immediate influences of association, as the consumption of oxygen, because in some instances the associate germ may be cultivated, the culture sterilized, the lactic bacteria inoculated into the sterilizing culture and the same associate results obtained.

Bearing in mind that enzymes would be destroyed by sterilization, that a combination of the associate micro-organisms in sterilized culture with the lactic micro-organisms will in some instances yield the same results, that no set of influences as oxygen, temperature, et cetera, is common to all cultures, the immediate agent causing the hastening of the action of lactic bacteria is indicated at least by a change in the culture which yields a more suitable food for the lactic bacteria.

PERSISTENT TYPES IN ASSOCIATION.

The well-known fact is apparent in these associational studies that nearly all filth micro-organisms disappear with the increased production of lactic acid. It is not so well recognized that there are types which can and do persist along with the lactic micro-organisms, and some of these are capable of causing a greater degree of acidity than may be yielded by the lactic micro-organisms in pure culture. Besides producing a greater amount of acid, they are frequently accountable for "off flavors" and "off aromas"—all of which are so troublesome to dairy workers.

DOES THE SPECIES OF BACTERIA PRESENT IN SAMPLES OF MILK HAVE ANYTHING TO DO WITH THE RAPIDITY OF SOURING?

Inasmuch as the associate micro-organisms exert a direct influence upon the lactic micro-organisms, it follows that the above question would be logical and pertinent. To answer it satisfactorily calls for the handling of a larger number of milk samples than have been studied in this article. However, we append a summary of counts and acidities which will convey some light.

SAMPLE I.

Time after milking.	Number of micro-organisms.	Acidity of milk.
0 hrs.	530	16°
20½ hrs.	49,500	16°
28¾ hrs.	275,000	16°
40¼ hrs.	69,000,000	16°
60½ hrs.	2,000,000,000	87°

SAMPLE II.

0 hrs.	1,380	16°
15 hrs.	720,000	17°
21 hrs.	7,670,000	23°
42½ hrs.	423,000,000	55°
69 hrs.	1,600,000,000	69°

SAMPLE III.

0 hrs.	221,000	17°
7 hrs.	1,780,000	19°
23 hrs.	3,800,000	19°
32 hrs.	204,000,000	19°
47 hrs.	1,633,000,000	43°
53 hrs.	1,936,000,000	63°
71 hrs.	854,000,000	72°

SAMPLE IV.

0 hrs.	22,000	15°
8½ hrs.	58,000	15°
24 hrs.	988,000	15°
32 hrs.	2,090,000	15°
48 hrs.	24,000,000	14°
56 hrs.	478,000,000	16°
72 hrs.	789,000,000	20°
80 hrs.	914,000,000	34°
96 hrs.	960,000,000	63°
104 hrs.	2,000,000,000	77°

The tables represent the samples of milk as they were brought to the laboratory and kept under uniform conditions.

In the first plates, by reference to each sample, it will be noticed that no lactic micro-organisms were determined as such, consequently it may be safe to regard all samples upon the same footing in this respect. That there were lactic bacteria present there can be no question, as has been shown by subsequent platings, but, how many, the first plates did not reveal.

To bring into bold relief the discords of these tables, or discrepancies, note that in Sample I, beginning with 530 micro-organisms at 0 hrs., it rises to 2,000,000,000 in 60⅓ hrs.; while Sample IV beginning with 22,000 micro-organisms at 0 hrs., mounts to only 789,000,000 in 72 hrs. Again Sample I gives 87° acidity in 60⅓ hrs.; Sample II, 55° in 69 hrs., with a beginning germ content of 1,380 as against 530 in Sample I. Still again, Sample II, with a beginning germ content of 1,380 produces 69° acidity in 69 hrs., when Sample IV, with an initial germ content at 22,000 in 80 hrs. rises to 34° only. These irregularities are numerous and accord with the usual laboratory experiences. While there may be some difference in the values of these samples of milk so far as their germicidal action is concerned or their capacity to grow bacteria, yet they were all mixed samples, consequently the differences must have been inappreciable.

The cause for the results given, since other factors are common to all, must lie in the variable germ content, and further the power possessed by the germ content to favorable or unfavorable association under natural milk conditions, unless it may possibly lie in the vigor or number of lactic bacteria present in each sample, which could not be satisfactorily determined until the later platings. (See the study of each sample.) To this may be added: Three samples came from the same dairy, therefore the lactic bacteria probably possessed the same vigor or readiness to grow or multiply.

We are disposed from our studies to attribute these irregularities to associative action and believe that experience will warrant this assumption from the data already offered.

ASSOCIATE MICRO-ORGANISMS AND "INFANT MILK."

These studies have this significance in connection with furnishing pure food to infants: While we have not demonstrated that the products with which we have been concerned in our associational studies are identical with the products which are instrumental as the cause of gastro-intestinal disturbances of infants, we have shown how rapidly these products are formed in milk and thus far are only detectable by means of association; for there may be no other apparent change in the milk and no alteration whatever which can be determined by any method available at the present time.

There is required the micro-organisms capable of growing in milk and coping with its associate micro-organisms in order to produce definite disastrous results. Again, the very associations may result in certain reactions which give origin to the substances causing intestinal trouble. Whatever may be the interpretation, it is patent that associate micro-organisms exert no salutary influence in "Infant Milk" unless it is by curtailing possible danger by hastening the souring.

STATEMENTS.

1. The sample of milk, the temperature, the number of bacteria present and other factors may change the results of combination, but an average result may be secured by holding to constant conditions throughout. This work is based upon one set of conditions only.

2. Because of the extensiveness of this work, it has been impossible to follow intensively any of the many questions which have been suggested, or which have pressed hard for recognition.

3. Much greater satisfaction would be ours had it been possible to work over each combination several times, and under somewhat different conditions. After once establishing what was regarded as a fair test controlled by checks, it became necessary to pass on. Throughout the investigations, two series of flasks were always conducted, one series being employed to check against the other.

CONCLUSIONS.

1. Bacteria, ordinarily found in milk, may or may not facilitate the growth of lactic micro-organisms.

2. About fifty-seven per cent of the associate micro-organisms when grown in combination with the specific lactic micro-organisms accelerate their growth and action.

3. The relative number of each micro-organism introduced into the combination may or may not have a decided influence upon the acceleration of the growth of the lactic micro-organisms of lactic fermentation.

4. Acceleration may occur at the beginning of the fermentation, or at the end, or at any stage between.

5. The means by which this acceleration of lactic fermentation is produced is not the same in all cases. It appears to be due to products manufactured by the associate micro-organisms, sometimes stable to heat, some times unstable; sometimes under alkaline conditions, sometimes under acid conditions; sometimes with apparent digestion, sometimes with no apparent digestion.

6. It is very doubtful whether these products combine with the inorganic

or casein constituents of milk, as is the case of lactic acid, so as to permit the lactic micro-organisms to grow more freely.

7. The period at the beginning of lactic fermentation during which no lactic acid formation can be determined, and during which the number of bacteria is continually increasing, may be greatly shortened by vigorous associate bacteria influencing the lactic micro-organisms.

8. Usually the associate micro-organisms disappear with the formation of appreciable amounts of lactic acid; yet the associate micro-organisms may continue or persist, causing an abnormal lactic fermentation.

9. Associate micro-organisms may influence lactic fermentation by producing "off flavors," "off aromas," and an unusual high degree of acidity. Even the character of the acid may be completely changed.

10. It follows that the elimination of "filth" bacteria is the only means of eliminating the product causing lactic acceleration, inasmuch as the products may be so stable as not to be destroyed by ordinary means of milk treatment.

We owe our gratitude to Mr. L. D. Bushnell and C. T. Burnett for some assistance in this work.

THE SOLVENT ACTION OF SOIL BACTERIA UPON THE INSOLUBLE PHOSPHATES OF RAW BONE MEAL AND NATURAL RAW ROCK PHOSPHATE.

BY WALTER G. SACKETT, ANDREW J. PATTEN, CHARLES W. BROWN.

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Of the many complicated questions which have claimed the almost undivided attention of the soil chemist and the soil bacteriologist during the past twenty-five years, the relation of microorganisms to the nitrogen of the soil stands paramount. Why this element should have received more than its share of consideration is without doubt due to the fact that it has been looked upon as of more importance than other plant foods, not only because of the recognized dependence of the plant kingdom, but also because of its greater money value and the limited supply which at present seems to be a matter of no little concern. Our better understanding of ammonification, nitrification, denitrification, nitrogen assimilation and fixation, together with the scientific explanation of the processes involved in these changes, stand out as witnesses to the excellent work of investigators who have given their entire time to concentrated research along these special lines.

Within very recent years, a second plant food element has demanded recognition of the soil biologist, namely, phosphoric acid.

According to Wiley,* phosphorus exists in the soil in four forms:—

"1. Phosphoric acid in phosphates.

2. Phosphoric acid in compound ethers similar to phosphoglycerates which dilute acids and alkalies decompose slowly with regeneration of phosphoric acid.

3. Mineral compounds of phosphorus of the order of phosphites which are resolved by oxidizing solutions like nitric acid with formation of phosphoric acid but which are only oxidized to this stage by the reagents employed after contact of indefinite length and uncertainty.

4. In the case of organic compounds of the order of the oxide of triethylphosphine, phosphorated phenyl compounds and cerebric acid with extreme difficulty by the usual reagents employed in the wet way."

"The mineral deposits of phosphorus as well as bone, are chiefly tricalcium phosphate while the slag compound resulting from the basic treatment of iron ores rich in phosphorus is a tetra-calcium salt."

Again in the natural, raw rock phosphate, we find calcium, iron and aluminum combined with the phosphorus in the form of double salts.

It is with such compounds as the two last mentioned which are only

* Principles and Practice of Agricultural Analysis, Wiley, Vol. I, p. 460.

slightly soluble in water and yet which are being used in the field quite generally and with success, as sources of phosphoric acid, that the present study is concerned. How are these insoluble compounds made soluble and thus rendered available for the use of plants? Are microorganisms in any way associated with this solvent action?

Soil chemistry, soil physics and soil bacteriology are all probably involved in the answer to such a question, since if microorganisms are to thrive in the soil, the proper physical conditions must be maintained. Again there are large numbers of inorganic and organic compounds including the weaker acids which have their origin in microbic fermentations and which possess more or less solvent power. These are of interest to the soil chemist. Many such compounds, however, must be accounted for by the soil bacteriologist and naturally the problem shapes itself into a study of the solution of insoluble phosphates by soil bacteria, yeasts and molds either directly, on the one hand, or indirectly, on the other, by means of the solvents resulting from decomposition and fermentation.

Stoklasa (1) has shown that when bone meal is employed as the insoluble phosphate, it has been possible to get as much as 21.56% of available phosphoric acid by inoculating a nutrient solution, phosphorus free, with B. megaterium, to which 10 grams of finely ground bone meal had been added. The bone meal he used contained 19.8% total phosphoric acid, 5.26% nitrogen and 1.5% fat, which is considerably lower in phosphoric acid and fat and higher in nitrogen than the average run of bone meal met with in this country. This may account for the marked difference between Stoklasa's results and those obtained in this laboratory. The following table taken from Stoklasa gives the results of his experiments based upon ten grams of bone and 900 c. c. of nutrient solution per flask inoculated with pure cultures and allowed to stand for 33 days.

TABLE No. 1. *Solvent action of pure cultures according to Stoklasa.*

Inoculation.	Grams P_2O_5 made soluble from 10 g. Bone meal.	Per cent of the total P_2O_5 made soluble.
Not inoculated	0.067	3.83
B. megaterium	0.427	21.56
B. fluorescens liquefaciens	0.182	9.19
B. proteus vulgaris	0.293	14.79
B. butyricus (Hueppe)	0.308	15.55
B. mycoides	0.456	23.03
B. mesentericus vulgatus	0.408	20.60

Stoklasa explains the increased soluble phosphoric acid in the inoculated flasks as due to the proteolytic and diastatic enzymes incident to the bacterial growth acting upon the insoluble tri-calcium phosphate of the bone.

To determine the action of these same organisms in soil, (2) he employed large unglazed pots filled with ordinary field soil in which oats were planted as the test crop. To all but one of these, five grams of bone

(1) Ueber den Einfluss der Bakterien auf die Knochenzersetzung. Centralbl. f. Bakt., Abt. II Bd. 6, S. 526. (1900).
(2) Ueber den Einfluss der Bakterien auf die Knochenzersetzung. Centralbl. f. Bakt., Abt. II Bd., 6, S. 554. (1900.)

meal were added. In the remaining one, the phosphoric acid and the nitrogen of the bone were replaced by their respective equivalents in superphosphate of lime and sodium nitrate. In addition to the bone, 2½ grams of glucose were added to some pots and the same amount of xylose to others while still other pots contained no sugar, the object being to determine whether the carbon dioxide resulting from the fermentation of these carbohydrates would exert an increased solvent action over the pots which contained no sugar. The pots were inoculated with 100 c. c. suspension of the different organisms employed six days before planting the oats. At the end of the growing period, the crop was harvested and separate weighings made of the grain and straw from each pot. Each series in the experiment contained ten pots and the results given are based upon the average of these ten. The results follow:

TABLE No. 2. *Stoklasa's Pot Experiments.*

Treatment of Pots.	Grain. g.	Straw. g.
Not inoculated. Bone meal	161.32	213.81
Not inoculated. Superphosphate and Chili saltpeter	213.98	260.13
B. megaterium. Bone meal without glucose	246.79	267.85
B. megaterium. Bone meal and glucose	285.88	306.11
B. megaterium. Bone meal and xylose	320.52	398.04
B. mesentericus vulgatus. Bone meal and glucose	283.21	353.77
B. mycoides. Bone meal and glucose	235.26	289.03
B. butyricus. Bone meal and glucose	230.79	285.99
B. fluorescens liquefaciens. Bone meal and glucose	165.26	272.26

By referring to Table No. 2, it will be seen:—

First, that in every case where the pots containing bone were inoculated there has been an increase in the crop over the uninoculated pots.

Second, the pots inoculated with B. megaterium to which glucose and xylose were added show an increase over the inoculated pot without sugar.

Third, all inoculated pots containing a carbohydrate, with the exception of the B. fluorescens liquefaciens series, gave a heavier yield than the B. megaterium pots with no carbohydrates. It seems unfortunate that control pots without the sugar were not prepared for each organism. Stoklasa attributes the greater weight of oats in the pots containing glucose and xylose to the carbon dioxide coming from the fermentation of these carbohydrates, acting upon the insoluble compounds of the bone and liberating phosphoric acid and nitrogen. This is undoubtedly an important factor in explaining the increased fertility providing all of the organisms experimented with are capable of producing carbon dioxide from the carboyhydrates named, but it is probably not the only one to be considered, since in the presence of such quantities of organic matter as occur in the average field soil, we should expect to find abundant material which would give rise to dilute organic acids when acted upon by soil bacteria. These acids, tho weak, nevertheless cannot be disregarded in a question of solubility.

Koch and Kröber (1) in their recent work have shown that a number of insoluble phosphates are rendered soluble by the acids formed by sewage and soil bacteria from dextrose. They have employed the same

nutrient medium as that used by Stoklasa, except that varying amounts of dextrose have been added in some cases and dextrose with beef broth in others. In some cases raisin-must has been substituted. The technique of their experiment is for the most part similar to Stoklasa except that instead of using pure cultures for the inoculation, very small quantities of liquid manure, soil or potato skin have been employed in the respective series. Bacteriological and chemical studies with bone meal, tri-calcium phosphate and Thomas slag showed that the bacteria with which the culture flasks were inoculated, produced acids from the dextrose capable of rendering the above compounds soluble, but that when calcium carbonate was introduced along with the phosphate, there was no longer any solvent action, the acid having been neutralized by the calcium carbonate as fast as formed. From this they conclude that the conversion of the phosphate into a soluble form is a much simpler process than Stoklasa believes it to be, stating that it is due simply to the solvent action of the organic acids and carbonic acid gas produced in the soil by the bacteria, rather than to the action of enzymes. The following table, No. 3, taken from their work will serve to give some idea of the nature and general plan of their experiment.

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(1) Der Einfluss der Bodenbakterien auf das Loslichwerden der Phosphorsaure aus verchiedenen Phosphates. Fuhling's Landwirtschafliche Zeitung, No. 7 April 1, 1906.

TABLE NO. 3. *Koch & Krober.*

No.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.
Solution.	250 c. c. Nutrient Solution* + 5 grams Dextrose + 2.5 grams Bone Meal.												250 c. c. Nutrient Solution* + 1% Beef Extract + 1 g. $Ca_3 (PO_4)_2$ = $(PO_4)_2$ + 5 g. Dextrose.						250 c. c. Nutrient Solution* + 1% Beef Extract + 1 g. Thomas Meal + 5 g. Dextrose.					
Ca added.	Without $CaCO_3$.						2 g. $CaCO_3$.						Without $CaCO_3$.						Without $CaCO_3$.					
Duration of Experiment.	46 days												46 days.						46 days.					
Culture.	Control.	B. mycoides.	Potato skin.	.012 g. earth.	½ c. c. liquid manure.	B. megaterium.	Control.	B. mycoides.	Potato skin.	.012 g. earth.	½ c. c. liquid manure.	B. megaterium.	Control.	B. mycoides.	Potato skin.	.012 g. earth.	½ c. c. liquid manure.	B. megaterium.	Control.	B. mycoides.	Potato skin.	.012 g. earth.	½ c. c. liquid manure.	B. megaterium.
Grams P_2O_5 in 100 c. c. Nutrient Solution....................	.017	.025	.037	.07	.186	....	0	0	0	0	0	0	.072	.079	.102	.196	.201	....	.047	.047	.052	.058	.09	....
Grams P_2O_5 made soluble by the Bacteria....................	....	.008	.02	.053	.169	....	0	0	0	0	0	0	....	.007	.03	.124	.129	....	....	0	.005	.011	.043	....

* Stoklasa—9000 c. c. H_2O.
1. g. K_2SO_4.
.5 g. $Mg Cl_2$.
.1 g. $Fe SO_4$.

Investigations have been conducted along similar lines in this laboratory for the past two years, during which time more than five hundred different determinations have been made. Our purpose from the beginning has been to demonstrate quantitatively, if possible, that the tri-calcium phosphate of raw bone meal and the insoluble phosphate of natural raw rock phosphate are made soluble by soil bacteria rather than to attempt any explanation of the processes involved.

PRELIMINARY DISCUSSION.

Knowing that the composition of a bacterial medium (1) influences the physiological activities of the organisms grown in it, the first problem to confront us was, naturally, the kind of a medium to employ to secure the optimum results. This was met by taking several media differing principally in the form and amount of the nitrogen they contained.

The exact composition of each solution is given under the discussion of its particular series. To 4 grams of bone meal prepared as herein described, placed in a 1,000 c. c. Florence flask, 250 c. c. of the bacterial liquid was added. These flasks were then sterilized in flowing steam for one hour on three successive days. The usual sterilization for twenty to thirty minutes by the discontinuous method was found to be unsatisfactory, owing to the presence of a very resistant spore-forming organism found in the bone.

After the third sterilization, all the flasks of a series were inoculated in triplicate from twenty-four hour agar streak cultures and placed in a constant temperature room at 23° C. to 25° C. All of the flasks were thoroughly shaken once a week during the whole period of experimentation. Each series contained 33 flasks, three of each culture and three uninoculated controls. Each series, unless otherwise stated, was examined quantitatively for soluble phosphoric acid after 30, 60 and 90 days.

Where the phosphate rock was used in place of the bone, 4.5 grams were taken for each flask, this amount being equivalent in phosphoric acid to that contained in 4 grams of bone.

BACTERIAL CULTURES.

The bacterial cultures used in our work were partly laboratory stock cultures and partly those isolated from agar plates made from a water suspension of garden soil. To the latter cultures have been assigned the laboratory numbers 1, 3, 4 (B. ramosus), 7, 8. The stock cultures were B. subtilis, B. mycoides, B. proteus vulgaris and B. coli communis.

BONE MEAL.

The bone meal which furnished the tri-calcium phosphate was obtained from Swift & Co., Chicago, Ills., and was known as Medium Pure Raw Bone Meal. It contained:—

25.5% Total P_2O_5
3.05% Nitrogen
1.9% Fat

(1) See page 27.

The bone was first sifted through a soil sieve of the following sized meshes: 2.0, 1.0, 0.5, 0.25 m. m. in the clear. The grade passed by the 1.0 m. m. mesh but retained by the 0.5 m. m. mesh was used, the other being discarded after screening. The following method was employed for removing the dry blood and waste soluble matter from the bone.

1. About 300 grams of the screened bone meal were steamed for two hours in one liter of a 0.5% salt solution using distilled water and chemically pure sodium chloride.

2. Cold tap water was then added, the contents of the vessel stirred thoroughly and allowed to settle when the top scum and the suspended blood particles were poured off from the surface. This washing was repeated from six to eight times, or until the bone was clean and white and free from all dark colored particles.

3. It was then transferred to a porcelain evaporating dish and dried over a water bath with frequent stirring when it was ready for use.

ROCK PHOSPHATE.

The rock phosphate was obtained in a finely ground condition from the South Carolina Mining and Manufacturing Co., Nashville, Tenn., and a chemical analysis showed it to contain:—

Insoluble Material	17.22%
CaO	35.10%
Al_2O_3	5.56%
Fe_2O_3	4.78%
P_2O_5	26.72%

ANALYTICAL METHODS.

On the specified dates, the flasks were taken to the chemical laboratory, the solutions filtered and made up to the volume of 500 c. c., from which duplicate samples of 200 c. c. each were taken for analysis.

The filtering of the solutions was accomplished at first with no little difficulty. Owing to the sliminess of many of the solutions, due to bacterial growths, filtering through paper was practically an impossibility, and it was only after the following scheme was devised, that this part of the operation was performed satisfactorily. A four-inch Buchner filter was used with a thick pad of long fiber asbestos as the filtering medium. Through this the solution passed quite rapidly, at the same retaining the finest particles of the bone and phosphate rock.

The digestion of the solutions was conducted as follows: Ten cubic centimeters of concentrated sulphuric acid were added to each flask, and after the excess cf water had been driven off by boiling, small quantities of concentrated nitric acid were added from time to time until the solutions were colorless.

The phosphoric acid was then determined according to the gravimetric method adopted by the Association of Official Agricultural Chemists.

DISCUSSION AND DETAILS OF THE EXPERIMENTS.

SERIES I.

The Nutrient Solution used in Series I. contained its nitrogen in the form of Asparagin and had the following composition:

Asparagin	5.0	grams
Sodium chloride	1.0	"
Potassium sulphate	1.0	"
Ferrous sulphate	0.001	"
Distilled water	1000.0	c. c.

Germ No. 8 gave the largest amount of soluble phosphoric acid in this series, 1.19%, while germ No. 1 produced the least, 0.51%. Detailed results are shown in Table No. 4.

TABLE NO. 4. *Solvent Action of Pure Cultures upon Bone in Asparagin Solution.*

Nutrient Solution:	250 c. c. Asparagin solution + 4 grams bone meal.*										
Culture used for the Inoculation.	Sterile Control.	Germ No. 1.	Germ No. 3.	Germ No. 4.	Germ No. 6.	Germ No. 7.	Germ No. 8.	B. coli communis.	B. mycoides.	B. proteus vulgaris.	B. subtilis.
m. g. P_2O_5 in 250 c. c. of the solution after 30 days..........................	4.8	6.5	6.8	7.5	14.0	5.3	10.3	12.5	10.0	9.0	12.0
m. g. P_2O_5 in 250 c. c. of the solution after 60 days..........................	4.5	9.5	9.5	10.8	13.5	11.5	10.5	11.5	7.3	16.0	13.8
m. g. P_2O_5 in 250 c. c. of the solution after 90 days..........................	3.8	10.0	13.8	10.8	11.3	11.8	18.3	10.3	10.8	14.3	12.5
m. g. P_2O_5 in 250 c. c. of the solution made soluble by the bacteria in 30 days.	....	1.7	2.0	2.7	9.2	.5	5.5	7.7	5.2	4.2	7.2
m. g. P_2O_5 in 250 c. c. of the solution made soluble by the bacteria in 60 days.	....	5.0	5.0	6.3	9.0	7.0	6.0	7.0	2.8	11.5	9.3
m. g. P_2O_5 in 250 c. c. of the solution made soluble by the bacteria in 90 days..	....	6.2	10.0	7.0	7.5	8.0	14.5	6.5	7.0	10.5	8.7
Maximum per cent of P_2O_5 made soluble by the bacteria..........................	....	.51	.83	.58	.76	.66	1.19	.63	.58	.95	.77

* The bone meal used in Series I, II, and III contained 30.32% total P_2O_5; all other Series 25.5%.

SERIES II.

The Nutrient Solution used in Series II. contained its nitrogen in the form of Peptone and had the following composition:

Peptone	5.0 grams
Sodium chloride	1.0 "
Potassium sulphate	1.0 "
Ferrous sulphate	0.001 "
Distilled water	1000 c. c.

Germ No. 8 gave the largest amount of soluble phosphoric acid in this series, 0.82%, while B. coli communis produced the least, 0.12%. While eight of the cultures shown in this series indicate a progressive solution, there are two others which seem to point to a reversion of the soluble salt after sixty days to the insoluble form at the end of ninety days. Thruout the series there is a considerable fluctuation in the results due either to an apparent reversion or to error in chemical determinations, the quantities in many of the analyses being so exceedingly small as to be overbalanced by the personal equation. Detailed results are given in Table No. 5.

TABLE No. 5. *Solvent Action of Pure Cultures upon Bone in Peptone Solution.*

Nutrient Solution: 250 c. c. Peptone solution + 4 grams bone meal.

Culture used for the Inoculation.	Sterile Control.	Germ No. 1.	Germ No. 3.	Germ No. 4.	Germ No. 6.	Germ No. 7.	Germ No. 8.	B. coli communis.	B. mycoides.	B. proteus vulgaris.	B. subtilis.
m. g. P_2O_5 in 250 c. c. of the solution after 30 days	2.5	5.0	4.5	2.8	4.3	6.0	5.8	3.0	7.8	4.0	4.3
m. g. P_2O_5 in 250 c. c. of the solution after 60 days	2.5	5.8	9.5	7.0	7.5	6.0	11.0	4.0	6.3	6.8	4.8
m. g. P_2O_5 in 250 c. c. of the solution after 90 days	3.5	9.0	7.8	8.2	8.3	6.8	13.5	4.3	7.8	11.0	9.8
m. g. P_2O_5 in 250 c. c. of the solution made soluble by the bacteria in 30 days.	....	2.5	2.0	.3	1.8	3.5	3.2	.5	5.3	1.5	1.8
m. g. P_2O_5 in 250 c. c. of the solution made soluble by the bacteria in 60 days.	....	3.3	7.0	4.5	5.0	3.5	8.5	1.5	3.8	4.3	2.3
m. g. P_2O_5 in 250 c. c. of the solution made soluble by the bacteria in 90 days.	....	5.5	4.3	4.7	4.8	3.3	10.0	.8	4.3	7.5	6.3
Maximum per cent of P_2O_5 made soluble by the bacteria	....	.45	.57	.39	.41	.29	.82	.12	.44	.62	.52

SERIES III.

The Nutrient Solution used in Series III. contained its nitrogen in the form of Beef Extract and Peptone and had the following composition:

BEEF BROTH.

Beef Extract (Leibig)	3.0	grams
Peptone (Witte)	10.0	"
Sodium chloride	5.0	"
Distilled water	1000	c. c.

Germ No. 8 gave the largest amount of soluble phosphoric acid in this series, 0.82%, while B. subtilis produced the least, 0.09%. On the whole this series shows the least solvent action of any. A possible explanation of this may be found in the fact that the beef broth being a better nutrient than either of the two preceding solutions, the germs have grown very vigorously at the start and have set free in the solution such quantities of decomposition products that the solution has become "auto-toxic," so to speak, for the culture. The vitality of the organisms thus lowered, their solvent action is reduced in proportion. Furthermore, it would seem from the negative results obtained on the thirty day analyses, that these decomposition products have exerted a decided reverting action upon the water soluble phosphates since in all but three cultures, the water soluble phosphoric acid after thirty days was less than in the sterile control. The detailed analyses are shown in Table No. 6.

TABLE No. 6. *Solvent Action of Pure Cultures upon Bone in Beef Broth.*

Nutrient Solution: 250 c. c. Beef Broth + 4 grams bone meal.

Culture used for the Inoculation.	Sterile Control	Germ No. 1.	Germ No. 3.	Germ No. 4.	Germ No. 6.	Germ No. 7.	Germ No. 8.	B. coli communis.	B. mycoides.	B. proteus vulgaris.	B. subtilis.
m. g. P_2O_5 in 250 c. c. of the solution after 30 days	7.5	4.3	5.3	3.8	7.5	6.0	10.3	2.8	6.3	5.5	8.3
m. g. P_2O_5 in 250 c. c. of the solution after 60 days	7.5	7.8	9.5	8.8	11.0	9.0	16.5	5.3	9.0	12.0	7.8
m. g. P_2O_5 in 250 c. c. of the solution after 90 days	8.3	10.8	15.5	8.3	11.3	9.5	18.3	8.5	6.8	15.3	9.5
m. g. P_2O_5 in 250 c. c. of the solution made soluble by the bacteria in 30 days	....	....	....	....	....	....	2.8	....	....	....	.8
m. g. P_2O_5 in 250 c. c. of the solution made soluble by the bacteria in 60 days	....	.3	2.0	1.3	3.5	1.5	9.0	2.2	1.5	4.5	.3
m. g. P_2O_5 in 250 c. c. of the solution made soluble by the bacteria in 90 days	....	2.5	7.2	....	3.0	1.2	10.0	.2	....	7.0	1.2
Maximum per cent P_2O_5 made soluble by the bacteria	....	.21	.59	.11	.21	.12	.82	.18	.12	.58	.09

SERIES IV.

Series IV. is in all respects like Series I. except that the bone meal has been replaced by its phosphoric acid equivalent in finely ground raw rock phosphate. Here the solvent action has been so slight as to be practically negligible, the maximum amount of phosphoric acid made soluble being 0.3% by B. subtilis as against 1.19% by germ No. 8 in the corresponding bone series. It may be noted further that the minimum amount of soluble P_2O_5 in the bone series, 0.51%, is considerably larger than the maximum, 0.3%, for the phosphate rock. The detailed analyses are given in Table No. 7.

TABLE No. 7. *Solvent Action of Pure Cultures upon Phosphate Rock in Asparagin Solution.*

Nutrient Solution: Asparagin Solution + 4.5 grams* phosphate rock.

Culture used for the Inoculation.	Sterile Control.	Germ No. 1.	Germ No. 3.	Germ No. 4.	Germ No. 6.	Germ No. 7.	Germ No. 8.	B. coli communis.	B. mycoides.	B. proteus vulgaris.	B. subtilis.
m. g. P_2O_5 in 250 c. c. of the solution after 60 days	7.8	8.3	8.8	10.5	9.0	5.3	9.5	7.3	8.3	7.0	11.8
m. g. P_2O_5 in 250 c. c. of the solution after 90 days	8.3	10.8	9.5	10.3	8.8	3.3	7.0	8.8	6.0	5.3	8.5
m. g. P_2O_5 in 250 c. c. of the solution made soluble by the bacteria in 60 days	....	.5	1.	2.7	1.2	....	1.7	....	.5	....	4.0
m. g. P_2O_5 in 250 c. c. of the solution made soluble by the bacteria in 90 days	....	2.5	1.2	2.	.5	....	....	.5	....	....	.2
Maximum per cent of P_2O_5 made soluble by the bacteria	....	.21	.1	.23	.1	....	.14	.04	.04	....	.3

* The phosphoric acid equivalent of 4 grams bone meal.

SERIES V.

Series V. is similar to Series II. except that the bone has been replaced by its equivalent in rock phosphate. The greatest action is shown by germ No. 6 giving 0.42% soluble P_2O_5 as against 0.82% by germ No. 8 in the corresponding bone series.

Not only is the amount of soluble phosphoric less here than in the bone series but the number of germs which show the solvent action is also fewer. The detailed analyses are given in Table No. 8.

TABLE NO. 8. *Solvent Action of Pure Cultures upon Rock Phosphate in Peptone Solution.*

Nutrient solution: 250 c. c. Peptone solution + 4.5 grams phosphate rock.

Culture used for the Inoculation.	Sterile Control.	Germ No. 1.	Germ No. 3.	Germ No. 4.	Germ No. 6.	Germ No. 7.	Germ No. 8.	B. coli communis.	B. mycoides.	B. proteus vulgaris.	B. subtilis.
m. g. P_2O_5 in 250 c. c. of the solution after 30 days	5.0	2.3	2.3	2.0	3.8	4.3	4.3	3.5	2.3	8.8	6.6
m. g. P_2O_5 in 250 c. c. of the solution after 60 days	4.8	3.8	6.5	6.0	9.8	5.0	5.8	5.0	5.3	6.5	6.8
m. g. P_2O_5 in 250 c. c. of the solution made soluble by the bacteria in 30 days	....	....	....	....	....	....	....	....	....	3.8	1.6
m. g. P_2O_5 in 250 c. c. of the solution made soluble by the bacteria in 60 days.	....	....	1.7	1.2	5.0	....	1.0	.2	.5	1.7	2.0
Maximum per cent of P_2O_5 made soluble by the bacteria	....	....	.14	.1	.42	....	.08	.02	.04	.32	.16

SERIES VI.

Series VI. is similar to Series III. except that the bone has been replaced by its P_2O_5 equivalent in finely ground phosphate rock. The maximum action is shown by germ No. 3, giving 0.46% soluble P_2O_5, as against 0.82% by germ No. 8 in the bone series. Four cultures have shown no solvent action whatever. Yet while fewer germs have given evidence of dissolution in this series than in any other, it will be noted that the amount of P_2O_5 made soluble by Germ No. 4, B. mycoides and B. subtilis is greater than the amount obtained by the corresponding germs on the bone. The detailed analyses are given in Table No. 9.

TABLE No. 9. *Solvent Action of Pure Cultures upon Phosphate Rock in Beef Broth.*

Nutrient Solution: 250 c. c. Beef Broth + 4.5 grams phosphate rock.

Culture used for the Inoculation.	Sterile Control.	Germ No. 1.	Germ No. 3.	Germ No. 4.	Germ No. 6.	Germ No. 7.	Germ No. 8.	B. coli communis.	B. mycoides.	B. proteus vulgaris.	B. subtilis.
m. g. P_2O_5 in 250 c. c. of the solution after 30 days........	8.5	8.3	12.0	10.3	7.3	7.2	8.5	9.8	13.5	9.5	11.0
m. g. P_2O_5 in 250 c. c. of the solution after 60 days........	11.3	8.8	18.8	15.0	11.0	9.5	8.3	10.0	15.3	13.0	16.0
m. g. P_2O_5 in 250 c. c. of the solution made soluble by the bacteria in 30 days.	....	....	3.5	1.8	....	....	....	1.3	5.0	1.	2.5
m. g. P_2O_5 in 250 c. c. of the solution made soluble by the bacteria in 60 days.	....	....	5.5	3.7	....	....	....	....	4.0	1.7	4.7
Maximum per cent P_2O_5 made soluble by the bacteria........	....	....	.46	.31	....	....	....	.11	.42	.14	.39

SERIES VII.

In Series No. VII., we have attempted to duplicate Stoklasa's work by using the nutrient solution which he recommends and which has the following composition:

Distilled water	1000 c. c.
Potassium sulphate	1.0 gram
Magnesium chloride	0.5 "
Ferrous sulphate	0.1 "

100 cubic centimeters of this stock solution were diluted with 800 c. c. of distilled water for each flask before use.

From the results shown in tables Nos. 4, 5, 6, 7, 8, 9, it will be seen that we have been unable to obtain anything like the quantities of phosphoric acid reported by Stoklasa. This has led us to follow up his work and repeat his flask experiments, using his special medium, the same organisms except for a possible difference in vigor due to attenuation, but different bone meal. At the end of 33 days, determinations were made for soluble phosphoric acid but still we were unable even to approach his results. The largest amount of phosphoric acid rendered available in any of our experiments thus far cited was 1.19% P_2O_5 by germ No. 8 in Series I. while the minimum quantity secured by Stoklasa was 9.19% by B. fluorescens liquefaciens. From this we must conclude that under the conditions of the experiment, the bone, being the only variable, must have been responsible for the difference in results. Our determinations duplicating Stoklasa are given in Table No. 10.

TABLE No. 10. *Solvent Action of Pure Cultures upon Bone in Stoklasa's Medium.*

Nutrient Solution:	250 c. c. Stoklasa's Medium + 10 grams bone meal.						
Culture used for the Inoculation.	Sterile Control.	B. proteus vulgaris.	B. ramosus.	B. mycoides.	B. megaterium.	B. mesentaricus vulgatus.	Germ No. 8.
m. g. P_2O_5 in 250 c. c. of the solution after 33 days..........	18.5	20.7	19.4	18.9	31.0	22.5	22.1
m. g. P_2O_5 in 250 c. c. of the solution made soluble by the bacteria after 33 days......	....	2.2	.9	.4	12.6	4.0	3.6
Per cent of P_2O_5 made soluble by the bacteria	....	.086	.035	.016	.5	.16	.14

While the actual amounts of phosphoric made soluble as shown in the foregoing tables covering Series I. to VII. are in many cases so small as to be outweighed by the error in chemical determination, there are yet innumerable instances in which there is no question as to there being more soluble phosphoric acid in the inoculated flasks than in the uninoculated. There has been a gradual increase in the phosphoric acid made soluble with each period of chemical examination and this increase in nearly every case has been much greater than would result from mere water solution as shown by the uninoculated controls. In other words the action has been a slow progressive solution.

At no time during the experiment has there been any indication of an acid reaction in the flasks, which fact seems to point to some force at work other then simply acid as suggested by Koch and Krober.

Satisfied then, from these experiments, that only very small quantities of insoluble phosphate could be made soluble without the intervention of an acid, our next step was to study the effect of some of the weaker acids upon bone meal as produced in vitro by bacterial fermentations.

SERIES VIII.

Lactic acid was the first one selected for our purpose since it could be obtained easily by inoculating sterile milk with a pure cultute of the lactic organism. 250 c. c. of skimmed milk to which 4 grams of bone meal were added gave the basis for the experiment. After sterilization, one set of the flasks was inoculated with a pure culture of B. acidi lactici and the other set kept for sterile controls. At the end of fifteen days, chemical determinations were made yielding the results given in Table No. 11. 25.31% of the bone phosphate was rendered soluble in 15 days by the lactic acid present in the sour milk.

TABLE NO. 11. *Solvent Action of the Lactic Acid from Sour Milk.*

Nutrient Solution:	250 c c. Milk + 4 grams bone meal.		
Culture used for the Inoculation.	Sterile Control.	B. acidi lactici.	Duration of Experiment 15 days.
m. g. P_2O_5 in 250 c. c. of the solution after 15 days	318.8	557.0	
m. g. P_2O_5 in 250 c. c. of the solution made soluble by the bacteria after 15 days	....	258.2	
Per cent of P_2O_5 made soluble by the bacteria	....	25.31	

SERIES IX.

Acetic acid as met with in the production of vinegar from beer wort was the second one studied. For this 250 c. c. of sterile wort containing 4 grams of bone meal were inoculated with a pure yeast, Saccharomyces cerevisiae, and the alcoholic fermentation was allowed to go on for three days at the end of which time a small piece of pure mother of vinegar was added to the flask. Acetic fermentation was set up at once and after fifteen days chemical determinations were made for the soluble phosphoric acid. The amounts found in the inoculated flasks and the uninoculated control are given in Table No. 12.

Here again we see the marked action of the acid liberating 53.55% of the total phosphoric acid.

There were probably small amounts of insoluble phosphate in both the milk and the wort which may have been acted upon by the acid present but these have not been taken into consideration and no correction has been made for them in reporting the soluble phosphoric acid as all derived from the bone meal.

TABLE No. 12. *Solvent Action of Acetic Acid from Beer Wort.*

Nutrient Solution:	250 c. c. Beer Wort + 4 grams bone meal.		
Cultures used for the Inoculation.	Sterile Control.	Yeast and Mycoderma aceti.	Duration of Experiment 15 days.
m. g. P_2O_5 in 250 c. c. of the solution after 15 days	118.3	664.5	
m. g. P_2O_5 in 250 c. c. of the solution made soluble by the bacteria after 15 days..................	....	546.2	
Per cent of P_2O_5 made soluble by the bacteria	....	53.55	

SERIES X AND XI.

For comparison with the lactic and acetic acid as produced from milk and beer wort respectively, two more series were prepared containing these acids in chemically pure form but diluted with distilled water so that the strength approached that found in the fermentation. This was done for two reasons:

First, to find out whether the dilute acids would have the same solvent action by themselves as when accompanied by the microorganisms and,

Second, to see how readily the bone would give up its insoluble phosphate under the action of the dilute acids.

So far as these two experiments go, they seem to show that the dilute acids are equally as active and even more so than the acids produced by the microbic fermentations in Series VIII. and IX. It would be perfectly natural to expect this on account of the possible loose combina-

tion of the lactic acid with the casein of the milk on the one hand and the acetic with the wort constituents on the other. In five days the 5% acetic acid had made available 75% of the P_2O_5 while the acetic germ in fifteen days showed only 53.55%, the acidity of the culture being a little less than 5%. Again, the 1% lactic acid gave 76.13% soluble P_2O_5 in five days while the lactic culture in milk of about the same acidity gave only 23.31% in fifteen days.

The details and results of these two Series are shown in Tables Nos. 13 and 14.

TABLE No. 13. *Solvent Action of Dilute Lactic Acid.*

Solution:	250 c. c. Dilute Lactic acid + 4 grams Bone meal.				
Strength of lactic acid used.	0.% Control.	.05%	.1%	.5%	1.%
m. g. P_2O_5 in 250 c. c. of the solution after 5 days	5.0	10.5	37.0	218.0	781.5
m. g. P_2O_5 in 250 c. c. of the solution made soluble by the acid after 5 days	....	5.5	32.0	213.0	776.5
Per cent of P_2O_5 made soluble by the acid	....	.54	3.13	20.88	76.13

Duration of the Experiment 5 days.

TABLE No. 14. *Solvent Action of Dilute Acetic Acid.*

Solution:	250 c. c. Dilute Acetic acid + 4 grams Bone meal.					
Strength of acetic acid used.	0.% Control.	.05%	0.1%	0.5%	1.0%	5.0%
m. g. P_2O_5 in 250 c. c. of the solution after 5 days	5.0	27.5	47.0	171.5	319.8	770.0
m. g. P_2O_5 in 250 c. c. of the solution after 5 days made soluble by the acid	....	27.0	42.0	166.5	314.8	765.0
Per cent of P_2O_5 made soluble by the acid	....	2.65	4.12	16.32	20.86	75.0

Duration of the Experiment 5 days.

CONCLUSIONS.

1. If it follows that the germs which produce the greater acidity in the medium give the most marked dissolution and that the solvent action occurs only in a medium in which there is a noticeable increase in the acidity, then we should say that the solvent is an acid or an acid compound produced by the bacterial growth.

2. But if there is a definite solvent action and no change in the acidity detectable, then we should say that the solvent action is not due entirely to acid compounds.

3. From all that we have gathered from our limited experiments, we are of the opinion that acid is not the sole solvent.

4. Certain soil bacteria under favorable conditions do have the power of converting small quantities of insoluble phosphates into a soluble form independent of acid formation.

5. When the bacterial growth is accompanied by acid formation, there is a decided solution of the insoluble phosphate.

THE INFLUENCE OF THE COMPOSITION OF THE MEDIUM UPON THE SOLVENT ACTION.

When bacteria are isolated from the soil, it is obvious to say that we are cultivating them upon a medium somewhat different than the soil itself; but if we find that a certain soil bacterium, when grown upon culture media, is capable of dissolving insoluble phosphates, we may suspect that this germ, even while growing in the soil, does have the power of making phosphorus available to plants.

Several experiments have been carried on to determine the influence of the composition of the medium upon the solvent action of certain soil bacteria. The materials experimented upon were rock phosphate, bone meal, tri-calcium phosphate, di-calcium phosphate and calcium carbonate. After these minerals were finely ground, the powders were shaken up with water and those particles which remained in suspension for over half a minute were poured into a filter and washed with water. A little of the washed powder was put into a flask of medium and sterilized in live steam under 15 pounds pressure for fifteen minutes. The sterilized medium was allowed to cool to between 50°C. and 60°C., then shaken to distribute the suspended particles equally. Plates were poured by using a sterile pipette to transfer about 8 c. c. of the medium to sterile Petri dishes. They were inoculated by a stroke on the surface of the solidified agar and placed in a constant temperature room at 22° to 23°C. to wait developments. Here they were examined daily for a visible solvent action which was made apparent by the suspended particles near the growth of the germ disappearing and the zone adjacent to the streak becoming clear and transparent. This is a crude quantitative method for detecting the solvent action of bacteria, but if a minute dissolution is to be discovered, a more sensitive method must be resorted to.

Ordinary nutrient agar was tried as a medium, but in no case was there a visible dissolution of any of the five minerals tried.

Nutrient agar containing 2% dextrose was used. This time several of the germs showed an action upon the calcium carbonate and the di-calcium phosphate, but no visible action was seen on either the bone or the rock phosphate.

A synthetic agar medium composed of .02% magnesium sulphate and ammonium respectively and 2% agar in tap water was tried with and without sugars. Into the first set of plates was poured the synthetic medium alone; into the second set the synthetic medium plus 4% saccharose; into the third, the fourth and the fifth sets of plates was poured the synthetic medium plus 1%, 2%, and 4% of dextrose respectively. Not a germ was found which gave any visible action in the plates containing no sugar; but, in the presence of the 4% saccharose, the 1%, 2% and the 4% dextrose, some of the germs gave a marked action upon the calcium carbonate and the di-calcium and tri-calcium phosphates. Some even dissolved those suspended particles which were, in cases, two centimeters from the growth of the germ. As before,

no definite action could be noticed upon the bone or rock phosphate. The solvent action of some germs seemed to be greater in the presence of the larger percentage of sugar, while that of others seemed to be as great with the 1% as with the 4%.

In order to get the cultural conditions more nearly like those existing in the soil, we used a medium composed of soil leachings with 2% agar. No solvent action could be noticed. But when sugar was added to this medium, the action was about as marked as that with the synthetic medium described above.

Now, if we used meat infusion—one liter of water to 500 grams of beef—instead of the water in the synthetic medium, we found that the solvent action exerted by the bacteria was not nearly so great.

It might be interesting to note here that according to our experiments those germs which, in the presence of sugar, are the most active acid producers are also the germs which, in the presence of albuminoids and the absence of sugar, are the most active alkali producers. And again these active germs are the ones which have shown the greatest solvent action.

Thirty-six out of fifty different bacteria isolated from the soil were found to give a definite, visible solvent action. One of these which produces no gas from sugars, but a larger amount of acid than any of the others, shows the greatest action upon the calcium carbonate; while other germs which produce gas, largely carbon dioxide, but not as much acid as the former, give an action more marked than that of the stronger acid producers upon the di-calcium and tri-calcium phosphates. These points, with others noticed during the experiments, have led us to believe that, while acid is an important factor is dissolving insoluble phosphates, the carbon dioxide liberated from the carbohydrates by the gas producing bacteria must not be overlooked as a solvent agent.

This agar plate method for determining the solvent action of different organisms, while only in a measure quantitative, has proven to be a very useful one in our studies with calcium carbonate, di-calcium and tri-calcium phosphates. However, with the more complex forms of the phosphate as met with in bone and phosphate rock, it has been unsatisfactory and has been found to be not sufficiently delicate to warrant our recommending it for general use with all insoluble compounds. The scheme commends itself especially where it is desired to determine in a rough way and in a short time the solvent action of a large number of microorganisms upon different media containing the insoluble compound in question.

Table No. 15 shows the relative number of soil bacteria giving a solvent action upon the secondary and tertiary calcium phosphates and calcium carbonate. The medium used was the synthetic agar containing 4% saccharose. As the results with the bone and the rock phosphate are all negative, owing to the rough plate method employed in obtaining this data, they are omitted from the table.

Legend for Table 15:

+ means, definite solution.
? means, suspected solution.
— means, no solution noticeable.

TABLE NO. 15.

Germ.	$Ca_3(PO_4)_2$.	$Ca_2H_2(PO_4)_2$.	$CaCO_3$.	Germ.	$Ca_3(PO_4)_2$.	$Ca_2H_2(PO_4)_2$.	$CaCO_3$.
A.	–	+	+	Y.	–	+	+
B.	?	+	+	Z.	–	–	–
C.	–	–	–	1A.	–	+	?
D.	–	–	–	1B.	+	+	+
E.	–	–	–	1C.	–	+	+
F.	–	–	–	1D.	+	+	+
G.	–	+	+	1E.	–	+	+
H.	–	–	–	1F.	+	+	+
I.	–	+	+	1G.	–	?	?
J.	–	–	–	1H.	–	?	?
K.	+	+	+	1I.	+	+	+
L.	–	–	–	1J.	–	+	+
M.	–	+	+	1K.	–	+	+
N.	–	–	–	1L.	–	–	–
O.	–	–	–	1M.	–	+	+
P.	+	+	+	1N.	–	+	+
Q.	–	+	+	1O.	–	+	+
R.	+	+	+	1P.	–	+	+
S.	–	–	–	1Q.	–	+	?
T.	+	+	+	1R.	–	–	+
U.	+	+	+	1S.	–	+	+
V.	?	+	+	1T.	–	+	+
W.	+	+	+	1U.	?	+	+
X.	–	–	+	1.	+	+	+
4H.	+	+	+	2.	+	+	+

In publishing the present work, the writers do it more as a preliminary report than as a finished product. We have had to feel our way rather blindly; many of the problems which have arisen have been fundamental and progress has been necessarily slow but when our more intensive investigations which we are now carrying on have been completed, we hope to be able to offer more definite data concerning the relation of bacterial fermentations to solvent action.

SPRAYING CALENDAR.

L. R. TAFT, *Horticulturist;* R. S. SHAW, *Director.*

[Special Bulletin No. 45.]

Farmers and fruit growers are beginning to understand the importance of the use of insecticides and fungicides to preserve their crops from the attacks of insects and diseases. To supply information as to the best remedies and the methods of preparing and using them, in a form that can be preserved so as to be convenient for reference, the following bulletin has been prepared. The remedies have been thoroughly tested, and if the directions regarding their preparation and application are carefully followed, they will be found effectual and can be used without danger to the foliage and fruit, or the health of the consumer.

Explanation.—While the entire number of applications given will be found desirable in seasons when insects and fungous diseases are particularly troublesome, and in the case of varieties that are subject to attack, a smaller number will often suffice. To indicate those that are of greatest importance, italics have been used, while others, that, although seldom required, may sometimes be of value, are printed in plain type. Whenever an asterisk (*) is used it cautions against spraying trees with poisons while they are in blossom.

Plant.	First application.	Second application.	Third application.	Fourth application.	Fifth application.
APPLE: (*Scab, codling moth, bud moth, canker worm, tent caterpillar, aphis*).	Spray before buds start, using copper sulphate solution. *For San Jose scale or aphis use the sulphur and lime mixture.*	*After the blossoms have formed, but before they open, spray with Bordeaux mixture and an arsenical.**	*Within a week after the blossoms fall, Bordeaux and an arsenical.**	12-18 days later, Bordeaux and an arsenical. Repeat, if necessary.	*Spray fall and winter varieties with Bordeaux and an arsenical about the first of August.*
CABBAGE: *Worms, aphis and flea beetle*).	*When worms are first seen, an arsenical. For flea-beetles, plaster and turpentine, or tobacco dust.*	*If worms reappear, repeat if plants are not heading.*	*After heads form, use hot water, pyrethrum, (or saltpeter a teaspoonful to a gallon of water).*	Repeat if worms reappear. For aphis use kerosene and water mixture.	(NOTE.—For the oyster-shell and scurfy scale on the apple, spray with lime whitewash and lye after the leaves drop.)
CHERRY: (*Rot, aphis, curculio, slug and leaf blight.*	*Before the buds open spray with copper sulphate.*†	*When the fruit has set, spray with Bordeaux mixture and an arsenical.**	10-14 days later, if slugs or signs of rot appear, repeat.	10-14 days later, weak copper sulphate solution if necessary, or soda Bordeaux.	For leaf-blight use Bordeaux mixture after the crop has been gathered.
CURRANT: (*Mildew, worms, borers and leaf blight.*	*When pruning cut out all stems that contain borers. As soon as worms are found on lower and inner leaves, spray with an arsenical.*†	*If worms reappear, repeat, adding Bordeaux for mildew and leaf spot.*	If worms still trouble, pyrethrum or hellebore.	After fruit is picked, Bordeaux for leaf spot.	
GOOSEBERRY: (*Mildew, leafblight and worms*).	*As leaves open, Bordeaux and an arsenical.*†	*In ten to fourteen days repeat with both.*	10-14 *days later use sulphide of potassium on English varieties.*	10-14 *days later, repeat.*	If mildew persists after crop is gathered repeat.
GRAPE: (*Rot, mildew, anthracnose, flea-beetle and leaf-hopper*).	Before buds burst, spray with copper sulphate solution. Add an arsenical for flea-beetles.	*When first leaves are half grown, Bordeaux and an arsenical. For leaf-hoppers use kerosene emulsion.*	*When fruit is set use Bordeaux and an arsenical.*	If necessary use Bordeaux at intervals of 10 to 14 days.	For powdery mildew use sulphide of potassium.
PEACH, APRICOT: (*Leaf curl, curculio, mildew and rot*).	*Before April* 1, *spray with copper sulphate solution.*†	*When fruit has set, use Bordeaux mixture and an arsenical, one-half strength.*	10-14 days later repeat.	If rot appears, use weak copper sulphate solution.	Repeat if necessary.
PEAR: (*Leafblight, scab, slug and codling moth*).	Before buds open, copper sulphate solution.†	*When the blossoms have formed, but before they open, Bordeaux and an arsenical.*	*Within a week after the blossoms fall, Bordeaux and an arsenical.**	Repeat in ten or twelve days, if necessary.	Use weak copper sulphate solution, or soda Bordeaux.
PLUM: *Curculio, rot, shot-hole fungus, black-knot*).	*Cut and burn black knots whenever found. Before buds open, spray with copper sulphate solution.*†	*As soon as the blossoms have fallen, use Bordeaux mixture and an arsenical.*	10-14 *days later repeat.*	Repeat if necessary, at intervals of 15-20 days, or use soda Bordeaux.	After fruit begins to color, use weak copper sulphate solution should rot appear.
POTATO: (*Blight, beetles and scab*).	*Soak seed for scab, in corrosive sublimate (two ounces to sixteen gallons of water), for ninety minutes.*	*When beetles or their larvae appear, an arsenical and lime water, or Bordeaux mixture.*	*Repeat whenever necessary.*	For leaf blight use Bordeaux, beginning when the plants are eight inches high.	Repeat every week or ten days if necessary.

Plant.	First application.	Second application.	Third application.	Fourth application.	Fifth application.
QUINCE: (*Leaf and fruit spots, slug*).	*Before the buds open, spray with copper sulphate.*†	*When the fruit has set, Bordeaux and an arsenical.*	10-12 days later repeat.	10-20 days later, Bordeaux.	
RASPBERRY, BLACKBERRY: (*Anthracnose, rust, cricket, slug and galls*).	*Cut out galls, crickets and canes badly diseased with anthracnose.* Before buds open, spray with copper sulphate solution.	*When new canes are one foot high, Bordeaux and an arsenical.*	10-14 days later, repeat.	After crop is gathered remove old canes, thin new ones and spray with Bordeaux if necessary.	(NOTE.—If red rust appears the entire stool affected should be grubbed out and burned.
STRAWBERRY: (*Rust and leaf eating insects*).	*Just before blossoms open, Bordeaux and an arsenical.*	After the fruit has set use Bordeaux mixture.	As soon as berries are harvested, Bordeaux, (if to be kept longer).	(NOTE.—Young plantations should receive first and third treatments given to bearing plants.)	(After harvesting mow and burn over the bed, if leaf rollers are found.
TOMATO: (*Rot and blight*).	*If either disease appears, Bordeaux.*	*Repeat if the disease continues.*	Repeat if necessary.		

† For the San Jose Scale upon apple and other trees use the sulphur and lime mixture. This is the best remedy for all scale insects, peach leaf-curl, aphides on fruit trees, twig borers, pear psylla, pear blister mite, etc., and when the self-cooked mixtures, or when the regular formulas are used at one-fifth strength it can be used as a summer spray for the San Jose Scale and as an insecticide.

FORMULAS.

BORDEAUX MIXTURE.

Copper Sulphate	2 to 4 pounds
Fresh Lime (unslaked)	4 to 6 pounds
Water	50 gallons

Care should be taken that the lime is of good quality and well burned and that it has not become air-slaked. If only a small amount is to be slaked it will be best to use boiling water, and the lime should not be allowed to become dry while slaking. When much Bordeaux is to be prepared, it is a good plan to make up stock solutions which can be mixed as required, proceeding as follows: Dissolve 40 pounds of copper sulphate in 40 gallons of water and in a box slake 60 or more pounds of lime. These can be kept for some time, but it is best not to prepare more than can be used in a week or ten days. Each gallon of the solution will contain one pound of the copper sulphate, and in preparing it for spraying, as many gallons should be used as are necessary to furnish the proper amount of copper sulphate. Thus for each 50 gallons required, 2 to 4 gallons of the solution should be placed in a barrel in which there are 26 gallons of water. An equal weight of lime, as near as can be estimated, should be placed in another barrel and 20 gallons of water added to this. After being well stirred, the lime mixture should be allowed to stand for a minute to give the coarse particles time to settle, and then the lime-water should be dipped out and slowly poured into the copper sulphate solution, stirring rapidly as the lime water is poured in. The mixture is then ready for use, but as there is danger of burning tender foliage if the amount of lime is insufficient, it is well to use some simple test, such as dipping a knife blade in the mixture, or adding a few drops of ferro-cyanide of potassium (yellow prussiate of potash). If the amount of lime is not sufficient copper will be deposited upon the knife blade, while the ferro-cyanide of potassium will give the mixture a deep brownish-red color. More lime should be added if necessary until no discoloration is caused in either case. An excess of lime will do no harm and is always desirable.

The copper sulphate can be easily dissolved, if suspended in the water in a coarse sack or basket. If the lime is properly slaked and is handled as recommended, there will be little trouble from lumps, but it is always well to strain the lime-water through a sieve, such as a piece of window screening.

This is the best remedy for fungous diseases except while the trees are dormant, or as the fruit is ripening. It is especially valuable for use with Paris green and other arsenites, as it lessens the danger of their injuring the foliage and the washing effect of rains.

DUST SPRAYS.

Attempts have been made to use copper sulphate and Paris green as dust sprays. Very unsatisfactory results have been secured when the dust sprays are used as fungicides but they answer fairly well against the codling moth and curculio, especially as the cost of the ap-

plications is much less than for liquid sprays. However, as the injury done by fungi is often greater than that by insects and it is always desirable to use Bordeaux mixture in liquid form, there will be little or no occasion for applying dust sprays of arsenicals as they can be readily added to the liquid Bordeaux mixture.

SODA BORDEAUX

Concentrated Lye	1 pound
Lime	5 ounces
Copper Sulphate	2 pounds
Water	50 gallons

Dissolve the copper sulphate and lye, and slake the lime in two gallons of hot water for each; mix the lime and copper sulphate solution and after adding the lye solution dilute to 50 gallons.

This is used upon the grape for the black rot and upon other fruits just before they are ripe.

COPPER SULPHATE SOLUTION.

Copper Sulphate	2 pounds
Water	50 gallons

For use before the buds open the above solution is fully as effectual as Bordeaux mixture and is easier to prepare and apply, but it should not be applied to any plant after the buds have opened. For use against the leaf curl of the peach this solution is especially desirable. If used before the middle of April a thorough application will entirely prevent the attack.

WEAK COPPER SULPHATE SOLUTION.

Copper Sulphate	1 pound
Water	150 to 200 gallons

A solution of copper sulphate of this strength can be used with safety upon nearly all plants. The stronger solution can be used upon all fruit trees except the peach, for which a weak solution would be preferable. Although less effective than Bordeaux mixture, the weak solutions of copper sulphate may be used to advantage where it is not desirable to apply mixtures containing lime. They seem fully as effectual as the ammonia solutions and are much cheaper.

POTASSIUM SULPHIDE.

Potassium Sulphide (liver of sulphur)	3 ounces
Water	10 gallons

This solution is valuable for the gooseberry and other powdery mildews, for which it seems even more effectual than Bordeaux mixture, although its effects are less lasting. It does not discolor the fruit and is quite harmless.

KEROSENE EMULSION.

This is a well-known remedy for use upon soft-bodied or scale insects that suck the sap. It is made from kerosene, water and soap, either hard or soft, or whale oil.

To one quart of water add one pint of soft or two ounces of hard

soap and heat until the soap is dissolved. Add one pint of kerosene and agitate freely for from three to five minutes, or until it forms a cream-like emulsion, from which the oil does not separate upon standing. This is a stock solution and can be kept for any length of time. Before using, it should be diluted according to the condition of the trees and kinds of insects. For scale insects it is desirable to spray while the trees are dormant, after diluting this stock solution so that there will be one part of kerosene to three of water, but if it is applied for the same class of insects while the trees are in leaf, the amount of water should be at least seven or eight times as great as of the kerosene in the stock solution. At this strength it will be fatal to all soft-bodied insects and to many of the scales, while for many of the insects with soft bodies it will be found sufficiently powerful if fifteen parts of water are used to one of the kerosene.

When making the emulsion with whale oil soap, the amount of the soap will vary with the amount of water it contains. If in a semi-liquid condition, one pint will answer for a pint of the oil, while four ounces will be sufficient if it is in a solid form.

In making the emulsion care should be taken to keep the kerosene away from the fire, and a force pump should be used rather than to rely upon a spoon or paddle.

SOLUBLE OILS.

The various "soluble" oils that are being sold for the control of the San Jose scale have been carefully tested but, while they killed a very large per cent of this insect, owing to the rapidity with which it breeds, the trees will be more thickly infested at the end of the season than before they were sprayed. Aside from being ineffectual against the scale at the strengths recommended, these remedies are quite expensive and have no fungicidal value. By using them three or four times as strong as recommended by the manufacturers their efficiency will be increased, but this will make their cost several times that of lime and sulphur and, unless very carefully used, injury may be done to the trees.

PARIS GREEN.

Paris Green	1 pound
Water	100 to 200 gallons

For the destruction of insects that eat the foliage or fruit. Paris green is a valuable remedy. It can be used in water in the above proportions, the stronger mixture being used for potatoes, while for fruits it is seldom advisable to use more than 1 pound in 200 gallons of water, unless in connection with lime water or Bordeaux mixture. It is always advisable to first form a paste with a small amount of water when preparing it for spraying. For low plants Paris green may be used in a powder form either alone or with one hundred times its weight of plaster. London purple is sometimes used in place of Paris green, but it is more apt to injure the foliage. Green arsenoid and arsenate of lead are valuable substitutes for Paris green.

ARSENATE OF LEAD.

Arsenate of lead	1 to 5 pounds
Water	50 gallons

The commercial brands of arsenate of lead now on the market contain from thirteen to twenty per cent of arsenious oxide and hence when used at the rate of one pound to fifty gallons of water furnish about the same amount as when Paris green is used at the rate of five ounces in fifty gallons. It is more effectual, however, when two pounds to the same quantity are used, and when the chewing insects are very large and quite numerous, it is often advisable to use three pounds in fifty gallons. For some insects like the rose chafer, which often appear in great numbers and die slowly, the use of five pounds, or more of arsenate of lead is recommended.

Arsenate of lead has the advantage over other arsenicals of having greater adhesive properties so that it is not as readily washed off by rains, and it can be used upon the most tender foliage without injuring it even though no lime is added.

Although the cost when two or three pounds are used in fifty gallons is somewhat more than that of Paris green, when the amount of arsenic contained is considered, the expense is little, if any, more.

WHITE ARSENIC.

As Paris green is quite expensive and is sometimes adulterated, white arsenic is frequently used in its place. Its cost is about one-third that of Paris green, and, as it is nearly twice as effective, the expense is only one-sixth as much as when Paris green is used. To prepare arsenic for use the following treatment is necessary: In two gallons of water place two pounds of freshly slaked lime and one pound of arsenic; after boiling thirty to forty minutes the arsenic will have dissolved and united with the lime, so as to form an insoluble compound. When desired for use the arsenic should be diluted, and one pound prepared as above will suffice for two to three hundred gallons when used upon fruit trees, or one hundred fifty gallons for spraying potatoes. That there may be no injury to the foliage, it is desirable to use the arsenic thus prepared either with Bordeaux mixture or lime water. When lime water is used, one pound of lime will be sufficient for twenty gallons of water.

LIME AND SULPHUR MIXTURE.

(For San Jose Scale.)

Lime (unslaked)	15 to 25 pounds
Flour of Sulphur	15 pounds
Water	15 gallons

Boiled one hour and diluted to fifty gallons.

The best remedy that has been found for the San Jose Scale is sulphur and lime prepared after the above formula. Where one has only a few acres of orchard to spray a jacketed iron kettle will answer for cooking the spray mixture. Place ten or fifteen gallons of water in a kettle and as soon as it boils add the lime. Fifteen pounds will answer if unslaked but the amount should be increased if much of it has become air-slaked. The maximum amount given above will not be excessive and as it will serve to whiten the trees and show the thoroughness of the spraying, it is often advisable. Make a paste of the sulphur and turn it into the kettle or sift it in slowly. The sulphur and lime should be thoroughly stirred while the lime is slaking, and occasionally until

the boiling has been completed. By continuing the boiling for fifty to sixty minutes the liquid will have changed to a reddish amber color, when it will be ready for use. In order to have all the sulphur dissolved, boiling for one hour will be safer than for a shorter period. Cold water can be used for diluting if it is not convenient to use warm water. While the mixture need not be boiling hot, it should be at least warm enough to prevent the crystalizing of the sulphur.

If a large quantity is required, steam can be used for boiling the mixture. This can be done either in barrels or in a tank holding 100 to 150 gallons.

The best results will be obtained when the spraying is done in the spring just before the buds open. Fairly good results can be secured in the fall, but winter applications will be found less effectual.

In addition to being the best remedy for the San Jose scale and other insects, the sulphur and lime solution is an excellent fungicide. When this has been used there will be no occasion for spraying with Bordeaux mixture previous to the setting of the fruit. It will also destroy the eggs of any insects upon the trees as well as any that are present in the other stages of development.

Although rather less effectual than the home-made mixtures some of the sulphur-lime solutions on the market are giving fairly good results.

HELLEBORE.

Fresh White Hellebore	1 ounce
Water	5 gallons

For insects that chew, and especially for the currant and cabbage worms.

PYRETHRUM OF BUHACH.

Pure Fresh Pyrethrum	1 ounce
Water	5 gallons

Valuable against both chewing and sucking insects, especially upon maturing fruits or vegetables, and upon flowering plants. It can also be applied in a powder form with a bellows.

CAUTIONS.

The copper solution should be made in wood, glass or earthen vessels, and should not be prepared in iron or tin.

Care should be taken against spraying plants of any kind with lime or poisonous mixtures within four or five weeks of the time they are to be used as food.

Study carefully the nature of the insect or disease and select the remedy that is most likely to destroy it without injuring the plants.

Do not spray while the trees are in blossom, as the bees will be destroyed; they are necessary to fertilize the flowers.

Pumps for the application of insecticides and fungicides should be sufficiently powerful to cover the trees or plants with a fine mist, and where copper compounds are to be used, the working parts should be of brass, and if all portions that are to come in contact with the spraying mixture are of brass, the durability of the pump will be greatly increased, except when the sulphur, lime and salt wash is used. For this an iron pump is better. It should have metal valves and should be rinsed out each day when through syraying.

REPORT OF THE SOUTH HAVEN SUB-STATION FOR 1907.

FRANK A. WILKEN.

Special Bulletin No. 46.

Prof. L. R. Taft, Horticulturist:

The following report upon the work of the South Haven sub-station for the year 1907, is herewith respectfully submitted:

The past season was cold and backward, and with an unusual amount of rain. Coming after the destructive freeze of October, 1906, it has been an especially hard year to the horticultural interests in this fruit belt, the frozen district.

In both January and February the temperature got so high as to draw the frost out of the ground. In March, also, we had a warm spell, which threatened to bring what remaining peach buds there were into blossom. In a few locations they did show color. Soon after, however, it turned cold and seemed to remain so throughout the season except for a few hot days in August. During early spring we had a comparatively small amount of rain, but from the latter part of May on we had an unusual amount.

Due to the cold weather the blossoms were three weeks behind their usual time for appearing, and lasted through an unusually long time. Many of the blossoms were frosted, especially those of the cherries and early strawberries.

The work at the station progressed very satisfactorily although much of it was of a repairing nature. Large apple trees that were crowded, especially in the north-west block, were taken out. Many trees of all kinds were reset and numerous minor changes and repairs were made on the grounds and buildings.

Several co-operative experiments were started but it was hard to get any of the fruit growers interested unless the experiments especially concerned some problem on their place. Some tests started are to continue for several years. Other tests giving results this year will be reported in another place.

STRAWBERRIES.

The freeze in May frosted nearly all of the blossoms on the early varieties. Both of the patches, the old and the new, also showed serious injury from the work of the white grub last year. The above conditions caused the poor crop we had this year. Due to the wet season the berries were somewhat soft and insipid. They failed to hold up well when placed on the market. The difference of time of fruiting between the early and late varieties was not as great as in other years.

The old standard varieties such as the Senator Dunlap, Warfield, Clyde, Bederwood, Uncle Jim or Dornan, Brandywine and Sample continued to bear well. The Bederwood was, as usual, the most productive

variety in the patch. Although it is rather soft and insipid here it is reported to do well in both color and quality on a reddish stiff clay on which kind of soil it originated. Uncle Jim is popular along this Lake Shore as it is a good light soil berry and stands up well. The main objection to it is its softness. Many regard it as lacking quality while to others it is a favorite.

Two early varieties, the Excelsior and August Luther are among the best for commercial purposes. They are quite similar in appearance, being of roundish conical shape and of a bright red color. The August Luther is a recent introduction. It does not bear quite as well but it is of better quality than Excelsior. Neither variety is very pronounced in quality, size or color; their chief value lying in their productiveness and earliness. Early Beauty, another early berry, is practically identical with Excelsior. The earliest good berry of any commercial importance is the Senator Dunlap.

The late varieties, Gandy, Nettie and Midnight are all of good size and quality but are rather light colored to be attractive, and are sometimes unproductive. Nettie has the best quality of the three, and Midnight is the latest, bearing after all others are through.

The following new varieties fruited on the station grounds this year:

Advance (Perfect).—Mid-season; berry of fair size and of good bright red color. Shape is a pronounced long conic. Quality is moderately good. The plants are small, light green, and appear to be somewhat tender. They do not seem to stand drought well. Needs further trial.

Abington (Perfect).—Mid-season, ripening at about the same time as Glen Mary. It is a chance seedling originating in Massachusetts. The fruit was of a bright red color, firm and of good quality. The plants have a strong healthy appearance and made a good growth.

Beavers (Perfect).—Introduced from the western coast where it does well, but here it proves a failure due to its poor plant-making qualities. It also seems tender in the winter. The Oregon and Velvet, also western varieties, fail on the same account.

Botham (Perfect).—A comparatively new variety reported on for the last two years. Last year it bore fairly well. The deep red berries which were of good quality were somewhat tender for shipping. This season, as two years ago, it proved a failure.

Buster (Imperfect).—Mid-season, ripening with Warfield. Hangs on well to the end of the season. Form, short conical, somewhat irregular. Color, bright red, flesh a little lighter. Quality good and texture firm. Somewhat hard to pick as the hulls pull off easily and the berries lie under the leaves. The most productive of the new varieties, and one of the best. The plant is a strong vigorous grower and a good plant maker. Very promising.

Cardinal (Imperfect).—Originated with Mr. G. J. Streater of Ohio. We have had it here for three years. The fruit is very attractive, of a deep glossy red color, and firm texture. The quality is good but is of a somewhat strong acid flavor. It would do well as a canning berry and also as a market berry. Here it lacks in plant-making qualities, the runners being few and slender. It may do well on heavy land but does not seem adapted to light soils.

Chipman (Perfect).—Received from Lincoln City, Delaware, where it is said to do well. The foliage is vigorous, dark green, and the plant hardy. The berry is irregular, roundish, conic, bright red in color, and fair in quality; flavor mild. Further trial will be needed to prove its worth.

Climax (Perfect).—Medium early, but lasts through a long season. Form flat conical, sometimes slightly furrowed. Color a medium light red and not very glossy; texture firm. Flavor, somewhat acid. Quality, fairly good. Plants good growers and one of the most productive of the newer varieties. Promising as an early variety.

Ekey (Perfect).—A large, pointed, irregular berry inclining to broad conic. It generally has a slight neck. Color good deep red; texture, inclined to be soft. Flavor good, mild. The plants are vigorous and thrifty, making plenty of plants. From its general appearance the variety might be considered a cross between Haverland and Uncle Jim. Its season is medium early and rather short. A promising variety. Productive.

Elma (Perfect).—A late variety ripening with Nettie. The color is darker than the Gandy. Form irregular, roundish conic. Quality very good, flavor mild. Size is generally large. Foliage is a deep glossy green. Plants vigorous. The most promising late variety under trial.

4 F (Perfect).—Received from Flansburg and Potter, Leslie, Mich. During the two years fruiting here it has made a poor showing. The plant is thrifty and vigorous, and is a very good plant maker. The berry is of good color, and broad conical in form. Flavor mild and pleasant. Mid-season in ripening.

Hecking No. 5 (Imperfect).—Berry roundish conical; color bright red and quality fairly good. Plants moderately vigorous. Lacks productiveness. Season late. Not promising.

Hummer (Perfect).—Large, conical, necked, sometimes wedge-shaped. Color bright red, generally white on tip and underside. Quality very good and texture firm. Plants large and thrifty. Season medium early. Somewhat of the New York type. Fairly productive. Needs further trial.

Kittie Rice (Imperfect).—While of very good quality and appearance, it does not bear well on light soil. The plants are moderately vigorous. Sometimes known as Downing's Bride.

Lucas (Perfect).—Medium large; roundish conical; dark red. Quality fair and texture moderately firm. The plants are very vigorous and are good plant makers. Moderately productive. Berries do not hold up well. Season medium early. Not good enough for a place in the standard list here.

Latest (Imperfect).—Plants bear large leaves but are not good plant makers. The color is an attractive bright red, a little darker than Gandy. Moderately firm. Quality good. Ripens with Gandy. Does not do well with us.

Malinda (Perfect).—Received from California where it is a popular variety. The fruit is of the Uncle Jim type as is also the foliage. Color of fruit is an attractive bright red and the quality is like that of Uncle Jim. It has no advantages over that variety and is not as productive.

Mead (Perfect).—Thrifty and a good plant maker. Foliage dark green and vigorous. Berry irregular, roundish, conical; firm, with a color of bright red. It bore moderately well. Needs further trial.

Morning Star (Perfect).—An early variety, which like all early varieties had many blossoms blasted. The berry is firm; roundish, conical. Color bright glossy red. Fruit holds up well through a fairly long season. Quality good. Plants moderately vigorous. Promising.

Mrs. Miller (Imperfect).—Introduced by the originator of Miller and as a companion to that variety. The berry is smooth, roundish, glossy red, firm in texture and of good quality. The plants have small dark-green leaves and are moderately vigorous as plant makers. Only fairly productive. Mid-season. Needs further trial.

Nimrod (Perfect).—A strong thrifty plant maker; foliage vigorous and of medium size. The fruit is of a bright glossy red color, of firm texture and good quality. Productive. Promising as a mid-season variety. Comparatively free from rust.

Nehring's Gem (Imperfect).—Plants thrifty and healthy. Berries roundish, conical, sometimes ridged. Color bright red; texture moderately firm. Fruit stands up well in shipment. Mid-season. Moderately productive. Needs further trial to prove its worth.

New Globe (Perfect).—Has large coarse foliage but the plants are not very thrifty. Fruit is bright red, irregular, roundish in form. Size generally large. Flavor rather acid. Texture moderately firm. Season late. Lacks productiveness here.

Pineapple (Perfect).—Foliage healthy and thrifty. A fairly good plant maker. Fruit is of the Uncle Jim type. Season later than that variety and quality a little better. Not productive enough to be of any commercial use. Has not much of the pineapple flavor for which it is named.

Peck No. 99 (Perfect).—Foliage thrifty and of a light green color. Plants set close to the ground and are only fairly good plant makers. Berries roundish, smooth. Color somewhat light. Quality good. Texture moderately firm. Fairly productive. Has no good points to make it popular.

Stevens Late Champion (Perfect).—A good thrifty plant with bright green foliage. Makes a good stand of plants. Berry roundish conical; color bright red. Flavor somewhat acid. Good for canning. Texture firm. Has not proved productive with us. Season late.

Virginia (Imperfect).—Fruit is large, rather light colored, and soft. Somewhat resembles Uncle Jim, but has no neck as has that variety. Quality moderately good. Season medium early, ripening a few days after Excelsior. Needs further trial here to thoroughly prove its value.

GOOSEBERRIES.

The gooseberry crop was good this year, Houghton, Industry and Pale Red bearing full crops. Orange, Josselyn and Champion also bore well. Of the English varieties, Columbus did the best, bearing three-quarters of a crop. Downing, the favorite American variety, bore a good crop, as usual. All of the varieties were comparatively free from mildew.

Some varieties pick easier, due to the character of the growth, length of spines, etc. The following were found easy to pick: Chautauqua, Industry, Pearl, Josselyn, Tree, Triumph and Columbus, while Orange, Pale Red, Downing, Houghton and Champion gave more trouble.

It is also noticed that the cane borer affects varieties to different degrees. With ten as being free from the borer the following varieties were affected as follows: Chautauqua 4, Champion 7, Columbus 6, Downing 8, Houghton 8, Industry 7, Orange 9, Pale Red 4, Pearl 3, Josselyn 7, Smith 2 and Tree 7.

All of the varieties fruiting this year were reported on fully in last year's report.

CURRANTS.

The crop of currants was good, many of the varieties bearing average crops. With ten as a full crop, they bore as follows: Champion 1, Cherry 7, Comet 6, English 1, Fay 8, Holland 8, Lakewood 8, London 10, North Star 8, Red Dutch 8, Ruby Castle 8, Select 8, Versaillaise 5, Red Cross 7, Pomona 4, Victoria 7, White Dutch 8, Wilder 7, White Gondoin 3, Wales 1, Saunders 2 and Lee 1.

The tendency of all the varieties was toward loose bunches which was undoubtedly due to the rainy weather at blossoming time. The fruit, however, hung on well. The presence of the aphis was not noticed this year.

The degree of freedom from cane borers was as follows: Champion 3, Cherry 8, Comet 6, English 8, Fay 5, Holland 7, Lakewood 4, Lee 2, London 6, North Star 6, Pomona 3, Red Dutch 7, Ruby Castle 7, Red Cross 6, Saunders 7, Select 7, Versaillaise 6, Victoria 1, White Dutch 6, White Gondoin 3 and Wilder 3.

CANE FRUITS.

Due to the freeze, we had no crop of blackberries and raspberries to speak of as most of the canes were killed to the snow line. In the spring all of the patch was gone over and the canes cut back to healthy wood.

Thrifty growing kinds as the Columbian purple cap seemed to be most seriously injured, while the early varieties of all of the cane fruits withstood the freeze comparatively well. The Rathbun blackberry had an especially nice crop of berries which were much larger than usual for that variety.

Following is a report of the condition of the varieties after the freeze. R denotes red raspberries, P purplecaps and B blackcaps.

Brilliant (R).—Not as seriously injured as many of the other red raspberries. Fair crop this year.

Cardinal (P).—Did much better than Columbian. Grew well this year.

Columbian (P).—Was seriously injured. Many bushes apparently healthy were killed. Did not grow very well.

Conrath (B).—Is doing only fairly well this season. Was killed to snow line.

Coutant (R).—Plants in poor condition last year. Seriously affected. Most of them were killed.

Cumberland (B).—Withstood freeze quite well. Had more fruit on new growth than other varieties. Growth good. New setting did not do as well as the old one.

Cuthbert (R).—Did better than most of the red raspberries. Made good growth.

Diamond (B).—Made a vigorous spreading growth this season after being killed back to the snow line.

Early King (R).—Killed back quite severely but grew well during the season.

Gregg (B).—Killed back considerable but grew well this summer. Old patch did not do as well as the new setting.

Haymaker (P).—Quite seriously injured, but did well during the growing season.

Idaho (B).—Made a moderately vigorous growth after being frozen back to the snow line.

Kansas (B).—Growth rather slow but it seems very healthy. Was killed to snow line.

Livingston (B).—Made a good dense growth.

Loudon (R).—Killed back quite severely and did not make a good growth this year.

Marlboro (R).—Plants rather poor last year and were seriously killed back by the freeze, many bushes being killed.

Miller (R).—Not doing very well, many bushes being killed, and those remaining made only a fair growth.

Mills (B).—Made a slow growth but otherwise the bushes are in good condition.

Nemeha (B).—Growth good, bushes vigorous.

Phoenix (R).—Did well, making a good growth. A little fruit.

Sarah (R).—Quite seriously affected. Plants weakened by freeze and made poor growth.

Shaffer (P).—While some of the bushes were killed, the remaining ones made a good growth.

Souhegan (B).—Some of the plants killed, others made a sparing growth.

Thompson (R).—Many bushes weakened, some killed.

Turner (R).—Plants poor last year and many were killed by the freeze. This variety is greatly subject to anthracnose.

BLACKBERRIES.

Early Harvest.—Did not stand the freeze as well as the other early varieties. Growth this year was fairly good.

Early King.—Was little affected by the freeze. Bore well, and was one of the best in the patch this year.

Eldorado.—Was badly injured, but made a good growth during the season.

Erie.—Not hurt as badly as the Eldorado. Growth was good.

Minnewaska.—Quite seriously injured, but growth during season was good.

Nevada.—Not badly injured. Withstood the freeze better than Wallace.

Ohmer.—Unevenly affected. Some bushes were quite seriously injured, and others very slightly.

Rathbun.—Stood freeze well, grew well, and had a better crop than any other variety of blackberry. The berries were of unusual size for Rathbun.

Snyder.—Was severely killed back, but made good growth during the summer.

Wallace.—Not very seriously injured. Made a moderate growth.

Wilson.—Was not killed back as much as many of the blackberries notwithstanding that it is a tender variety. Made a fairly good growth.

CHERRIES.

The crop of cherries was the smallest we have had in years. The blossoming was only light, and many of the blossoms were frosted. Montmorency Ordinaire was the only variety that had a full crop. No variety of sweet cherry had anything but some scattering fruit. The Dukes also had poor crops, the Montrueil and Olivet with about half crops being best. The Morellos all bore fairly well but the fruit was poor and undersized. The popular Richmond bore about a half crop.

The October freeze did not injure any of the sour varieties, but the Dukes and sweet cherries were slightly affected; the Russian varieties Baltavar, Badaccony and Modnyansky were killed outright, even though they were protected by the hedge.

PEACHES.

The freeze was most disastrous on this fruit, all of the trees in the frosted district being killed except in the most favorable locations, and those with protection from the west and north. All of the trees at the station were killed, including those set last year. The spaces occupied by peaches in the northeast and northwest blocks were reset.

During the latter part of August the ends of the limbs turned yellow to about half their length while the lower half was of a healthy green color. Taking the head of the tree as a whole it appeared as if the outer part was yellow while the center was green. This was undoubtedly due to the souring of the soil caused by the incapacity of our drains to carry off the excessive moisture brought by the frequent rains we had. In digging grape post holes near the newly set trees we struck water about two and a half feet down which emitted an odor similar to that of marsh gas. This with the cold season and the fact that some of the trees were from nurseries in the frozen district and were probably slightly affected was the cause of the trees doing so badly this year. The poor condition of the newly set trees was noticed in numerous places.

PLUMS.

The plum crop was fairly good, Green Gage, Monarch, Bradshaw and Lombard bearing full crops. The Grand Duke, Archduke, Coe, G No. 4, Foot and Damsons also bore good crops. It was noticeable that varieties located under the influence of the west and north hedges bore the

best crops. Those varieties on the east side of the grounds bore very little.

None but the Japanese varieties were affected by the freeze, and, due to the protection of the hedge, they were not as seriously injured as in other places in this vicinity. The Satsuma and Red June were the only varieties killed, and they would have withstood the freeze better if they had been in better condition before. The Abundance seemed to come through it better than any other Japanese variety.

All varieties were comparatively free from their usual troubles such as the curculio, rot and shot-hole fungus.

PEARS.

The following varieties had good crops this year: Howell, Sheldon, Winter Nelis, Mount Vernon, Zache, Flemish, Buffum, Longworth and Kentucky. The last three and Zache, all pears of poor quality, had full crops, but the pears of high quality, Seckel, Danas Hovey and Bosc, had very little fruit.

The foliage of all varieties kept in good condition. There was no effect of the psylla nor of the blister mite noticed. The fruit was also comparatively free from scab.

APPLES.

The crop of apples was much better than expected. The varieties in the northwest corner of the grounds where they got the most protection from the north and west hedges had the best crops. Several varieties in the southeast block also bore well. The following varieties had full crops: Shiawassee, Thompson 29, Thompson 39, McIntosh, Canada Baldwin, Bailey Sweet, No. 1 New, Whitney No. 20, Wagener, Gloege, Jonathan, Buckingham, Longfield, Nansemond, Duchess, Minkler, Stuart's Golden, Wealthy, Peter, Walker, Indian, North Star (crab), Water, Lady Sweet, Ontario, Grimes, Lawver, Arnold, Limber Twig, Kinnaird, Golden Sweet, Boiken, Stark, Fameuse Sucre, Palinor, Horse, Doctor and Hamilton Black.

Much Bordeaux injury was perceptible during the season, due to the weather conditions. Damp rainy weather is favorable to the russeting caused by the Bordeaux mixture. Some varieties are more susceptible to it than others, and generally it is the varieties most susceptible to scab, while those with the tender skin are more susceptible to both than varieties with a rather tough oily one.

The following varieties had considerable russeting, (Bordeaux injury) upon them: Barry No. 5, Jersey Sweet, Garden Royal, Shiawassee, Jonathan, Ratsbury, Winter Banana, Sweet Orange (bad), Palinor, McIntosh, Thompson 29, Thompson 39, Ben Davis (bad), Wagener, Wall Sweet, Gloege, Fameuse, Quaker (crab), Golden Sweet, Longfield, Arnold, Excelsior (crab), Martha (crab), Grimes, Mason Orange, McMahon, Nyack, Ontario, Louise, Hurlbut, Tolman, Townsend, Mother, Boiken, North Star, Paragon and Rambo.

The following varieties are not subject to it at all, or very little: Northern Spy, McKinley, Longkeeper, Doctor, Borovinka, Arkansas, Black Twig, Akin, Springdale, Rainbow, Bath, Bosnian, Dudley, Keswick,

Red Astrachan, Early Strawberry, Titovka, Early Joe, Dickinson, Duchess, Canada Baldwin, Lowell, Bailey Sweet, No. 1 New, Evans, Stark, Ronk, Glowing Coal, Indian, Kinnaird, Oldenburg, Pewaukee, Fanny, Bietigheimer, Water, Wolf River, Munson and Walker.

GRAPES.

As the freeze killed back all of the grape vines, advantage of the opportunity was taken and the trellises were changed from the four horizontal overhead wires to the more common way of having two wires, one above the other. The old method, forming a T-shaped system, presented a very nice appearance in the vineyard but was rather troublesome for both spraying and picking, as all of the grapes grew on the underside and were completely covered by leaves. It necessitated getting down on one's knees under the vine to pick the fruit. This method also shaded the fruit from the sun.

New posts were put in throughout the entire vineyard. With few exceptions all of the vines sprouted at the base and all but the strongest shoot was removed and on this the side shoots were rubbed off so that all of the energy was used in an upward direction. Then the shoots were trained to a string tied to the wire overhead.

There was no difference noted in the resistance of varieties to the freeze. Vines on poorer soil suffered most, some of them dying, and those with a tree to the north suffered the least. There was no fruit except on the Worden, which had protection from neighboring trees.

QUINCES.

The quince crop was better than that of any other fruit. All varieties bore well. Alaska had the best crop. Fuller and Missouri Mammoth also had very good crops. Angers, VanDeman, Orange and Rea bore moderately well. For size and appearance the fruit of the Missouri Mammoth was the best. All of the fruit was comparatively free from blemishes.

NUTS.

None of the nuts bore except a few hazelnuts. The freeze seriously affected the Japanese walnuts, both the Sieboldiana and the Cordiformis. The entire top was killed except in limbs that measured three inches in diameter, or more. Due to the fact that it was hard to tell how much of the wood was killed during last winter and that the tree bled after the sap started, the trees were left untouched until the present dormant season.

The new growth of the chestnuts was killed on most of the varieties. The Japanese chestnuts were all killed and all of the nuts on the trees at the time of the freeze were destroyed.

The hazelnuts and filberts were not affected at all, and it is a peculiar fact that, although the pecan is a southern tree and is too far north to bear, it was not injured.

CULTURAL METHODS.

All of the test plots started last year had to be reset and started again. This year with the reset blocks we started tests in the blocks with four varieties of Japanese plums, one row each of Abundance, Red June, Burbank and Satsuma; three rows, one each of the following European plums; Grand Duke, Bradshaw and Monarch; also one row each of Wagener, Wealthy and Oldenburg apples and Engle's Mammoth, Kalamazoo and Elberta peaches. Each of these plots are divided into three sub-plots, one of which will be treated by the usual mulch method of culture, another by cultivating until the first week in August and then seeding to a cover crop, and the other will be cultivated the same as the second, but no cover crop is to be sown. The trees will be brought up under these various methods of culture and the results noted from time to time. The experiment will be well under way by next year. A similar experiment was started on bearing Wagener trees in the orchard of Mr. C. J. Monroe of South Haven.

The pears and cherries in the northeast block and the pears in the southeast block have been left in sod for the last three years without any perceptible change in their condition. The cherries in the southwest block were put in sod this year.

FERTILIZERS.

Several tests of commercial fertilizers on fruit trees and of the difference in commercial fertilizers, barnyard manure and cover crops were started both at the station and cooperatively. It was with some trouble that places to do the cooperative work were obtained. Two places were secured, those of Mr. C. J. Monroe and Mr. Geo. Chatfield, both of South Haven. Next year an endeavor will be made to obtain other places so that the tests will be of more general application. They will be continued through a term of years and results will be noted frequently.

SPRAYING.

The station orchard was sprayed this spring with lime-sulphur mixture. The work was started during the latter part of April and was continued until the buds had well started. The opening buds of the pears were slightly injured by the late spraying but not so much but that they overcame the injury by the middle of the season. It had been previously noticed that the opening buds of the pear and apple are more susceptible to late spraying of lime-sulphur than those of the peach. As the spraying was done late in the season it was allowed to take the place of the first spraying with Bordeaux mixture as a fungicide and served most efficiently for that purpose.

Having tested most of the prepared scale-destroying mixtures for several years, the tests this year were limited to the newer ones that had not been tested by us. The freeze seriously interfered with the results, many of the trees sprayed dying during the summer. Many scale were also killed by the freeze and it will not be possible to give precise and satisfactory results this year.

The following preparations were tested last spring and compared

with the home-made lime-sulphur wash: Rex Lime-Sulphur solution made by the Rex Company of Omaha, Nebraska. It is claimed, and analysis shows it to be pure lime-sulphur solution in a concentrated form. It is a clear reddish-amber liquid with a strong sulphur odor, and resembles the home-made mixture after the solid substance settles. It has been used successfully for scale in some of the western states. When sprayed on the trees it gives them a slight whitish tint. It mixed readily with water and sprayed easily. In the early part of the season it seemed effective, but toward the latter part of the summer quite a few scale were found, enough to show that it was not as effectual as the home-made mixture. However, it is as good as any of the prepared mixtures we have used. It can be brought for $12 per barrel of fifty gallons from local dealers, and when mixed at the rate of one gallon of the Rex solution to eleven of water the price of the mixture ready for spraying is $1 for fifty gallons of spray. As the mixture needs no heating and there is little trouble in preparing it, this price is not excessive, and the mixture would prove a valuable one for persons with a few trees should it prove effective when tested under better conditions. From the analysis we would advise its use at the rate of one part to ten parts of water and that five pounds of lime be added to each fifty gallons to assist in securing a good job of spraying. The Niagara Lime-Sulphur solution is very similar.

The Lion brand of Lime-Sulphur solution is said to be a concentrated solution of lime and sulphur made by James A. Blanchard Co., New York City, and contains insoluble matter resembling that found in the home-made mixtures. It is used at the rate of one gallon of the mixture to forty of water. It was tested both at that strength and at the rate of one part to twenty parts, but in neither case did it do effective work. Unless it is carefully strained, it clogs the nozzles.

The Water Soluble Oil sent out by the Thomson Chemical Company of Baltimore, Maryland, was also tried. The results from its use were similar to those from other soluble oils. The home-made lime-sulphur is preferable to any of the soluble oil preparations, or to any prepared mixtures for the destruction of the scale, that we have tested especially when the cost is considered.

The above results, although quite convincing to the experimenter, cannot be taken as conclusive as the tests were not made under very good conditions.

During the summer, the second week in August, the limbs and some of the leaves of a few trees each of apples, cherries, plums and pears were sprayed with the full strength (15 lbs. sulphur, 25 lbs. lime and 50 gals. water) and half strength of the home-made lime-sulphur mixture and also several trees of each kind with the Rex lime-sulphur mixture at the strengths of one to eleven and one to twenty. This was done to test the practicability of using either of these mixtures during the summer on the main limbs of trees that were getting badly infested during the season, as a check to the progress of the scale during the growing season. Neither mixture, at either of the strengths used on any of the trees, caused the slightest burning of the leaves.

This is contrary to our experience of former years. Three years ago various mixtures were tried and most of them burned the leaves. Our

results this year can not be accounted for unless it be due to the unusual amount of rainfall. Next year we expect to repeat this test.

ARSENATE OF LEAD AS AN INSECTICIDE.

In the orchard of Mr. C. J. Monroe, the common arsenites used in the spraying were tested to get comparative results. On one row of apples arsenate of lead at the rate of three pounds in 50 gallons of Bordeaux mixture was sprayed three times; viz.: 1st, immediately after the blossoms dropped; 2nd, ten days later, and 3rd, during the first week of August. On another row, Paris green was used at the times mentioned above. White arsenic prepared according to the Taft formula (boil 4 lbs. of arsenic and 8 lbs. of lime in 8 gals. of water one hour. Use for 600 gallons of spray.) On another row, arsenate of lead was sprayed twice, the first time being immediately after the blossoms dropped and the last during the last week of August.

After counting the fruit and sorting out the wormy ones we got the following results: arsenate of lead, sprayed three times, 24 per cent wormy; Paris green, three times, 34 per cent wormy; white arsenic, three times, 80 per cent wormy, and arsenate of lead twice, 74 per cent wormy. Mr. Monroe states that the spraying had to be hurried and that the trees were not given nearly as thorough a spraying as he would have liked to give them.

In our regular spraying at the station we used arsenate of lead in comparison with Paris green on the trees in the southeast block. A count and investigation of the results gave us the following: Arsenate of lead, 2 per cent wormy and Paris green, 5½ per cent wormy.

Both of the above tests show the superiority of the arsenate of lead over the other arsenites. Other things in favor of it are that it never burns the foliage and sticks on well. An objection to it is its expense, but the high price that good fruit always brings warrants the fruit growers in using it.

For our regular spraying we used Bordeaux mixture in the following strengths: First, before the blossoms opened, four pounds of copper sulphate to five pounds of lime in fifty gallons of water; second spraying when the fruit has set, three pounds copper sulphate and four pounds of lime; third spraying, ten days later, same as second; fourth spraying, during the first week in August, two pounds of copper sulphate and three pounds of lime. The result was entirely satisfactory, especially when two to three pounds of arsenate of lead was added for each fifty gallons.

MICHIGAN

STATE AGRICULTURAL SOCIETY

MICHIGAN STATE AGRICULTURAL SOCIETY.

REPORT OF THE TRANSACTIONS OF THE SOCIETY AND PROCEEDINGS OF THE EXECUTIVE COMMITTEE FOR THE YEAR ENDING JUNE 30, 1908.

OFFICERS FOR 1907-8.

President—Fred Postal, Detroit.
Vice-President—L. Whitney Watkins, Manchester.
Secretary—I. H. Butterfield, Detroit.
Treasurer—John McKay, Romeo.
Business Manager—C. A. Floyd.

EXECUTIVE COMMITTEE.

(Term ending January, 1908.)

A. J. Doherty	Clare, Clare County.
W. J. Galbraith	Calumet, Houghton County.
Wm. T. Terney	Roscommon, Roscommon County.
L. C. Holden	Sault Ste. Marie, Chippewa County.
F. B. Ransford	Caro, Tuscola County.
W. W. Collier	Pontiac, Oakland County.
L. R. Taft	Agricultural College, Ingham County.
Geo. B. Horton	Fruit Ridge, Lenawee County.
D. D. Aitken	Flint, Genesee County.
B. E. Hall	Port Huron, St. Clair County.

(Terms expire January, 1909.)

T. F. Marston	Bay City, Bay County.
Archibald J. Peek	Jackson, Jackson County.
A. E. Stevenson	Port Huron, St. Clair County.
C. A. Tyler	Nottawa, St. Joseph County
Nicholas J. Whelan	Holland, Ottawa County.
Wm. Dawson	Sandusky, Sanilac County.
Vincent V. Green	Detroit, Wayne County.
Lawrence W. Snell	Highland Park, Wayne County.
Geo. Kelly	North Branch, Lapeer County.
Daniel Thomas	Pontiac, Oakland County.

EX-PRESIDENTS.

(Members Ex-Officio.)

T. W. Palmer	Detroit, Wayne County.
John T. Rich	Lapeer County, P. O. Detroit.
I. H. Butterfield	Detroit, Wayne County.
E. Howland	Pontiac, Oakland County.
Eugene Fifield	Bay City, Bay County.

STANDING COMMITTEES.

Business—A. J. Doherty, Lawrence W. Snell, I. H. Butterfield.
Finance—D. D. Aitken, Eugene Fifield, N. J. Whelan.
By-Laws and General Rules—W. J. Galbraith, A. E. Stevenson, V. V. Green.
Premium List—A. J. Doherty, I. H. Butterfield, Lawrence W. Snell, Eugene Fifield, the President.
Reception—John T. Rich, A. E. Stevenson, J. F. Brand, B. E. Hall, Wm. Dawson.
Program—The Business Committee, President and Marshal.
Cattle—C. A. Tyler.
Horses, except for Speed—L. C. Holden.
Horses, Speed—Eugene Fifield.
Sheep—W. E. Boyden.
Swine—George Kelly.
Poultry—Daniel Thomas.
Farm and Garden Products—W. J. Terney.
Dairy—Lawrence W. Snell.
Apiary—F. B. Ransford.
Farm Implements and Machinery—Vincent V. Green.
Vehicles—A. E. Stevenson.
Main Building—C. A. Floyd.
Art—A. H. Griffith.
Needlework—Mrs. Belle F. Clark.
Horticulture—Prof. L. R. Taft.
Educational—George B. Horton; Assistant Superintendent, Thos. M. Sattler.
Mining Exhibit—W. J. Galbraith.
Gates—Finance Committee.
Marshal and Superintendent of Police—A. J. Peek.
Concessions—The Business Committee.
Transportation—D. R. Hurst.

IMPROVEMENTS DURING THE YEAR.

The society has made good progress during the year in improving the grounds and the general equipment needed for the purpose of holding a fair.

The electric light line was extended to cover the railroad docks making the loading and unloading of cars possible during the night.

The walks and drives have been improved, shrubs and trees added, and much cleaning up has been done.

In February, 1908, a contract was made with the Detroit Driving Club for a five year's lease of the track and stables, the club to expend ten thousand dollars or more on the track and in building new stables.

Work on the track was begun in April and nearly ten thousand dollars was expended on the track alone, making it one of the best in the country.

Two new stables were added at a cost of six thousand dollars, making one hundred sixty-eight stalls in the speed barns.

Concrete walks were constructed from the electric railway entrance to the grand stand passing the main building. This walk is twelve feet wide and substantially built.

Concrete was also laid, covering the area in front of the grand stand. The total square feet of concrete laid is about 60,000.

A septic tank and filter has been put in through which the sewerage from the grounds passes and which has received the approval of the health authorities as being sufficient to prevent offensive matter from entering the county ditch which passes through the grounds.

During the year the Grand Trunk Railway put in two more sidings each 1,000 feet long, which adds materially to the convenience of transportation.

A building for the use of the Detroit City Fire Department, to house engine and crew during the fair, was erected at a cost of $800.

THE FAIR OF 1907.

Was held under favorable conditions, the weather being fine except for one day.

The exhibits were about the same as in 1906, as was also the attendance. The total receipts were also about the same, but the expenses were greater and the net receipts somewhat less.

The financial result appears in the reports.

Much more space is needed for the exhibits, as several departments now have but temporary quarters and the implement and machinery, and the vehicle department have no housing at all.

An administration building, woman's building, manufacturers' building and, most of all, a live stock amphitheater are needs in the line of buildings.

MEETING OF THE EXECUTIVE COMMITTEE.

Meeting of the Executive Committee held at the office of the President, Monday, September 2, 1907, at seven o'clock P. M., called to order by the President.

Roll called—quorum present.

On motion, the place for holding the annual election was ordered to be at the press booth in office building.

On motion, L. L. Kelly of Clare county, T. D. Seeley of Oakland county and James Slocum of Wayne county were appointed judges of election.

On motion the caucus of the society was ordered to be held at the Michigan building on the west porch on Wednesday, September fourth, at 10 o'clock, A. M.

A live stock parade was ordered for Wednesday, September fourth, at 11 o'clock, A. M., under direction of Superintendent Tyler.

A protest was received from M. A. Bray & Son regarding ages of swine exhibited by J. A. Teter in the open to all classes.

On motion, the protest was referred to Supt. Geo. Kelly, who late

reported that it had been shown to his satisfaction that the ages of the swine protested were as represented by the exhibitor and that the protest should not be sustained.

Mr. L. A. Wise presented a proposition for the purchase of land fronting Woodward avenue, adjoining the grounds. The consideration of the matter was put over to next meeting.

On motion, adjourned to Friday, September sixth, at 10 o'clock A. M.

MEETING OF THE SOCIETY.

The annual meeting of the society was held at the Michigan building, Wednesday, September fourth, at 10 o'clock, A. M.

Called to order by the President. Eugene Fifield was named as chairman and I. H. Butterfield, secretary.

On motion, the chairman was instructed to appoint a committee of three on nomination of officers.

The chairman appointed Robert McKay of Macomb, George W. Dickinson of Oakland, and N. P. Hull of Eaton.

A recess was taken for five minutes. After five minutes, meeting again called to order by the chairman.

The committee on nomination reported as follows:

For President—Fred Postal of Detroit, Wayne county.

For Vice-President—L. Whitney Watkins, of Manchester, Washtenaw county.

For Secretary—I. H. Butterfield of Detroit, Wayne county.

For Treasurer—John McKay of Romeo, Macomb county.

For members of the Executive Committee for two years—A. J. Doherty of Clare, Clare county; D. D. Aitken, of Flint, Genesee county; W. J. Terney of Roscommon, Roscommon county; L. C. Holden of Sault Ste. Marie, Chippewa county; W. W. Collier, of Pontiac, Oakland county; L. R. Taft, of Agricultural College, Ingham county; Geo. B. Horton, of Fruit Ridge, Lenawee county; W. J. Galbraith, of Calumet, Houghton county; F. B. Ransford, of Caro, Tuscola county; and Charles L. Edwards of Carleton, Monroe county.

On motion the secretary was instructed to cast the ballot of the society for the names proposed, as nominations for officers for the ensuing year. The ballot was so cast and the chairman declared the persons so named to be the nominees of the society, to be voted for at the election, to be held on Thursday, September 5th.

On motion adjourned.

ELECTION.

The annual election was held pursuant to rules and regulations and by direction of the Executive Committee at the press booth in office building on Thursday, September fifth, from nine o'clock, A. M., to five o'clock, P. M.

The judges of election heretofore appointed, having taken the oath of office organized by the appointment of L. L. Kelly, chairman and James Slocum, secretary.

At five o'clock, P. M., the polls were closed and the judges, with the president of the society, counted the ballots with the following result:

For President, Fred Postal of Detroit, Wayne county....	65
For Vice-President, L. Whitney Watkins of Manchester...	65
For Secretary, I. H. Butterfield, of Detroit, Wayne county.	65
For Treasurer, John McKay of Romeo, Macomb county....	65

For Members of the Executive Committee for two years:

A. J. Doherty, of Clare, Clare county..................	65
D. D. Aitken of Flint, Genesee county..................	65
W. J. Terney, of Roscommon, Roscommon county.........	65
L. C. Holden, of Sault Ste. Marie, Chippewa county.......	65
W. W. Collier of Pontiac, Oakland county...............	65
L. R. Taft, of Agricultural College, Ingham county......	65
George B. Horton of Fruit Ridge, Lenawee county........	65
W. J. Galbraith of Calumet, Houghton county............	65
F. B. Ransford of Caro, Tuscola county.................	65
Chas. Edwards of Carleton, Monroe county..............	65

The president announced the result of the balloting and declared the persons above named duly elected.

Meeting of the Business Committee, September 16th. Further routine business and settlement of accounts.

Frank Freegard was engaged as caretaker of the fair grounds at $700 per year and house, to begin Sept. 9th.

Meeting of the Business and Finance Committees, October 1, 1907.

The Business Committee was authorized to construct a house for the caretaker.

It was decided to issue notes of the society to the amount of $25,000 to pay existing indebtedness.

On motion adjourned.

ANNUAL WINTER MEETING OF THE EXECUTIVE COMMITTEE HELD AT THE GRISWOLD HOUSE, DETROIT, BEGINNING MONDAY, JANUARY 13TH, AT 8 O'CLOCK, P. M.

Called to order by the President.

Roll called and the following named members present: Messrs. Peek, Stevenson, Tyler, Whelan, Green, Snell, Kelly, Doherty, Galbraith, Terney, Holden, Ransford, Collier, Taft, Aitken, Edwards, Fifield, Postal (president), Watkins, Butterfield, McKay and Mr. Edwards, new member elect.

The president read his annual address.

President's Address.

To the Board of Directors of the Michigan State Agricultural Society:

I herewith submit to you my report for the year ending December 31st, 1907.

It is needless for me to state that without the untiring devotion of each and every officer, the gratifying results of this period could not have been obtained, and I desire in this report to commend to your board these officers for their hearty co-operation in all that seemed best for the ultimate success.

The Michigan state fair is for the people of Michigan. The state has assisted it. Its commercial and educational value cannot be questioned. The past has demonstrated that the expenditure on the part of the state government was a wise one, and it is hoped that the unqualified endorsement of the people will warrant a more liberal appropriation in the future.

In my report I have covered only in a general way matters of particular interest in connection with last year's fair, and offer to you such suggestions as have presented themselves in connection with our previous experience.

I am inclined to think that in the past we have not given enough attention to details, at our annual meetings, and I hope that there will be a free and full discussion on each and every suggestion and recommendation contained in the following report.

A detailed report of the various transactions of 1907, will be submitted by the proper officers.

The gross receipts as compared with 1906, show a decrease.

The gate receipts were approximately sixty thousand dollars.

The advance sale of tickets shows an increase of five thousand dollars over 1906.

Railroad coupons received amount to twelve thousand seven hundred and sixty dollars, or a decrease of six hundred dollars as against 1906.

The amount received from concessions was thirty-three thousand dollars, an increase of forty-five hundred dollars over 1906, one-half of this increase came from our proportion of side show receipts.

The sale of membership tickets shows a decrease and the premium list advertising an increase.

The disbursements show an increase of about thirteen thousand dollars.

Twenty-five thousand dollars was paid in premiums as against twenty-two thousand dollars in 1906.

Ten thousand dollars less was spent for free attractions than in 1906.

Eight thousand four hundred dollars was spent for advertising of every description as against seven thousand dollars in 1906.

Four thousand dollars more was spent for interest on 1906 improvement notes.

Eighteen thousand dollars was expended in improvements in 1907.

The net profits for 1907 fair amount to approximately twenty-seven thousand dollars.

The decrease in gate receipts was due to one day of unfavorable weather and closing grounds on Sunday.

I believe that our action as to Sunday closing was well taken, still experience has shown that a very large number of excursionists and local people who have no other diversions, desire that they be permitted to visit the grounds Sunday. With the closing of all business and amusement attractions, I believe that the best interests of all concerned would be served by opening the grounds Sunday for those who desire the opportunity of visiting the grounds in the same manner that our city parks or Belle Isle might be visited, and I recommend this action to your board.

The first recommendation I have to make is in connection with the finances. The association has outstanding, in addition to its one hundred thousand dollar first mortgage bonds, eighty-two thousand dollars in miscellaneous notes which come due at various times and being payable to several parties, furnish a constant source of annoyance and inconvenience. Our records show that we have now an investment of over four hundred thousand dollars. The first mortgage covering this property amounts to one hundred thousand dollars, and the second mortgage is for one hundred thousand dollars more. The second mortgage bonds are not desirable. I would recommend that as soon as money conditions improve, a new first mortgage be executed for two hundred thousand dollars. The first mortgage bond holders could be satisfied, the floating indebtedness of the society be entirely wiped out and at the same time leave a balance to make some very necessary improvements.

The duties of treasurer have been greatly increased under the present plan, and I would recommend that he be authorized to appoint an assistant with authority to sign checks, and do the necessary clerical work in connection with his office; a man who would be in Detroit so as to be in close touch with the business office of the fair.

Among the improvements which were made this year were a water supply tank, fire engine house and a new electric light transformer station. In addition to this, under the able supervision of Superintendent Fifield, our mile track has been made one of the fastest and best in the country.

Splendid improvements have been made in the grounds under the

supervision of Secretary Butterfield and Professor Taft. Trees and shrubs have been planted and walks laid out and driveways improved, and our grounds are the most attractive in the country.

The Grand Trunk Railway has constructed additional side tracks in accordance with my recommendation of last year. These tracks have served to make the fair much more popular with exhibitors.

The new department organized to look after transportation has been successful and should be continued.

While we are all aware of the fact that a great deal of money could be put into additional desirable and almost essential improvements, still I can hardly feel like recommending any great investment under existing circumstances.

From the last three years' experience, I would recommend that benches be placed in the band grove where visitors may rest and eat their lunches in comfort.

We should plan for the future to have a structure where the implement and vehicle exhibits could be placed under cover. The manufacturers would gladly pay the association for such space, as they would save the money they now expend for tents. Before this fair reaches its full importance it must have a building where power is furnished to show the process of manufacturing the different commodities made in the state.

Our races have been handled in a commendable manner, nevertheless, the superintendent of the speed department will agree that a great improvement can be made if the association provides for several big stakes. If this were done the number of other purses may possibly be cut down and the public interest in the races increased.

A proposition will be made, which if accepted would provide a track which would be unexcelled and would increase the receipts of the association.

Among the important improvements in the operating end of the fair, I mention the following: Wholesalers of supplies and produce have been provided with buildings on five year contract. It is now convenient for state fair visitors to go to the grounds in automobiles since the checking system and reservation of space for machines has been made. The live stock parade, through the grounds made a decided hit and adds considerable interest.

The night shows as conducted last year were not only profitable in themselves, but helped the concessions and the Wonderlust considerably. The class of free attractions and the program before the grand stand received much favorable comment and helped to make the fair popular. In the Wonderlust itself were many shows of unusual interest. This feature is necessary to the success of such an institution as ours. The management found itself short of ground space for this department and due allowance should be made in the future.

I think I express the sentiment of this body when I say that the exhibits of minerals, while attractive to a few, does not give satisfactory results when the item of expense is considered. We are too far away from the mineral district for a successful exhibit of this kind. I would recommend that in its place we show an elaborate collection of war relics and historical souvenirs.

The school exhibit attracts considerable attention and I think can

be made much more attractive by featuring some of the exhibits. Manual training is receiving more attention throughout the country, and I believe that if we go into this end of school work, offering competition between the different schools of the state, it will prove very successful.

Upon a careful investigation it has been found that a pet stock show could be arranged in connection with the fair. In this show, dogs could be exhibited on one or two days; cats and other pet stock during the balance of the week. It would be much better of course to have a building for this kind of a show, but a tent could be used temporarily. If this were done an admission fee should be charged which would more than defray the expense incidentals. If this meets with your approval, the premium committee should be instructed to provide for proper awards. The National associations of the various classes would willingly send their cups to our fair.

There should be a distinction in the live stock departments between stock which is brought to the fair purely for sale purposes and that which is sent here to compete for premiums. It would hardly be well to try to eliminate the selling and buying of stock on the grounds, still provision should be made for this end, on account of the overcrowded condition of the exhibit buildings.

Your attention is called to the fact that while our fair has grown wonderfully, its scope broadened, its convenience increased and simplified, and the attendance greatly increased, yet the stall and pen rents remain the same. Where we charge but fifty cents, other associations charge one dollar, and where we get but two dollars for a box stall, others get three dollars.

If our fair association is to make a good financial showing, we must not forget to carefully watch its sources of revenue. At the same time we must be careful not to drive our exhibitors away. I would recommend that we make an advance in these fees.

At the last fair we incurred an expense of thirteen hundred dollars in the forage department for straw which was distributed "free" to stockmen. Other fairs charge the actual cost for the straw furnished and I believe that we should do the same and save quite an amount.

My attention has been called by the report of the superintendent of cattle department, relative to having two classes for cattle, sheep and swine in the premium list open to all classes and Michigan class.

The latter was, I understand, established in 1901, in the effort to fulfil the conditions of the legislative act making an appropriation for the payment of premiums on live stock and exhibits owned or produced in the state.

It was also contended that our herds and flocks could not compete with those from other states, especially with the large herds that wealthy stockholders should be able to fit for show purposes.

I believe the time has come when we can safely make but one class, by enlarging the premiums and extending them to fourth or even fifth premiums in classes having strong competition, and inserting senior and junior classes for the younger animals.

I think we could comply with the terms of the appropriation act

in so doing, for we would still be paying more than the amount appropriated to stock and articles owned in Michigan.

Our breeders are now in shape to compete with outsiders on even terms as may be seen in the awards in the open classes at the last fair.

By extending the number of awards to fourth and fifth premiums, the small exhibitors will be better cared for than they are now, as even in the state classes there are state herds that take all the first premiums after competing in the open class.

I ask the committee on premium list to fully consider this matter, and I recommend a change to one class for each breed. My attention has been called to an infraction of a rule in the poultry department, which I think works against the interests of the society and against the smaller breeders of poultry. I am informed that some exhibitors secure poultry in large numbers, for the express purpose of securing a large bunch of premiums. Most of these exhibits are borrowed from various owners, and bunched together and shipped from one fair to another in car loads and in some instances these exhibitors have taken hundreds of dollars in premiums. This is very discouraging and detrimental to the small breeder, and has a tendency to discourage instead of encourage the breeding of good stock and should be discouraged. The object of awarding premiums is to encourage the breeding of improved varieties of fowls. This kind of an exhibit does not accomplish that end. We have a rule in this department requiring that all fowls must be the property of the exhibitor who must also be a breeder of the variety shown by him. If this rule were enforced the injustice which I mentioned would be avoided, and I recommend that the rule be enforced.

The entrance fee should also be increased to twenty-five cents for each fowl and fifty cents for breeding pen as we now feed all the fowls.

There has been much talk about the advance sale of tickets, and a careful consideration should be given this item. I believe under proper restrictions this is a very successful and paying proposition. Factories purchase quantities of tickets which they distribute to their employees. Wholesalers buy blocks of advance tickets and sell them to their trade through the state. Stores give these tickets to purchasers. All of this tends to increase the attendance. Many persons who would not go otherwise are induced to visit the fair. I think that plans could be devised to dispose of many advance sale tickets out in the state. In case of stormy weather during the fair, the advance sale tickets would help very materially in keeping the ticket sales somewhere near the expected fair weather sale.

The restriction which should be placed upon this sale is that they are not to be sold in small lots during the time the fair is open and this can be required and rigidly insisted upon.

In my last year's report I called attention to the abuse of free admission tickets. An effort was made this year to restrict passes. I am very glad to learn that less than one-half the number of free admissions were presented at the 1907 fair than the one previous. Still the problem has not been entirely solved and I would suggest that a new plan be formulated and put into effect. I have drawn up a brief draft of a suggestive scheme for this purpose and I recommend that a committee be appointed to look this over, make what changes their

judgment calls for and report at once to the executive committee so that a definite order may be issued. Under this plan the exhibitors in the dairy and merchants' main building would receive no passes whatever.

Those who exhibit for premiums in the needle and art work department would have membership tickets for which they would pay one dollar and would receive one admission ticket good on the first day of the fair. The same class of exhibitors in the poultry, dairy, apiary, sheep, swine, cattle and horse departments would be required to purchase an exhibitor's ticket at two dollars which would include one coupon ticket containing an admission for each day of the fair.

The implement and vehicle exhibitors would receive one eight coupon ticket entitling the bearer to admission once on each day of the fair, for say each one hundred square feet of space taken.

Concessionaries would be entitled to one eight coupon ticket for their fee of twenty-five dollars or less, and then at the rate of forty single admissions for each one hundred dollars on their contract and pro rata. Special contract like the bar and pool privilege, and side show would get tickets according to the actual number of necessary employes.

The actual employes of the association would have the eight-coupon admission ticket. Officers and directors would have annual passes. Policemen and sheriffs would be admitted on their official badges. The Detroit newspapers would be taken care of through the manager of such papers only. State newspapers would be cared for the same way as this year. The free attraction people would have single admissions issued to them daily. Other necessary passes would be issued carefully and curtailed as much as possible.

I would suggest that a resolution be passed by this body, placing proper restrictions on issuing passes, which will furnish those who have the handling of passes good and sufficient excuse for refusing passes to those who are not entitled to them, and who each year secure same, thereby, imposing upon their friends and causing financial loss to the state fair.

I have reports from the different departments in my possession. The cash reports I am referring to the finance committee.

The suggested changes in the premium list, I will hand the premium committee.

There are demands for increased facilities and they will be turned over to the 1908 business committee.

Our finances, when the approved accounts of 1907 are paid, will show a bank balance of about twenty-seven hundred dollars. Mr. O'Hearn owes us six hundred dollars, and this together with a few small items due, added to this balance will amount to thirty-six hundred dollars, which should carry us until the time concession money begins to come in, (if our notes are renewed) including the twenty-five hundred dollar bond interest due April 1st. I desire to submit for your special commendation the services of general superintendent Doherty and manager Floyd. The real burdens rested with them and the results show that each well and creditably performed his full duty.

I desire also to speak of the most excellent and satisfactory manner in which the newspaper publicity department was conducted by James Slocum.

To you, the members of the board, I can only express my warmest appreciation in behalf of myself and our Michigan people for your many personal sacrifices and hearty cooperation.

In conclusion I am deeply sensible of the honor and responsibility conferred upon me in being again selected as Chief Executive and can assure you that my best efforts will be given for the continued prosperity and success of the institution in which I feel we are all so sincerely interested.

Sincerely yours,
FRED POSTAL,
President.

REPORT OF GENERAL SUPERINTENDENT.

Mr. President and Gentlemen of the Executive Committee:

I beg leave to briefly give you the workings of the Agricultural Society for the past year. At your meeting in January, 1907, your instructions to the Business Committee were that they carefully keep expenses down to a minimum, not in any way injuring or hindering the general working of the society. With that end in view, your Business Committee has carefully pruned every item possible. In June of last year we had the misfortune to lose by fire our electric transformer house, together with sundry electric fixtures and one large transformer; the total loss being about $1,100. This handicapped us to the extent of building a new building at a cost of $88.00.

We found that our electric lighting system was costing us too much. The reason of this was that we owned none of the material necessary. The transformers and material used in the past were loaned from the Edison Electric Company, and had to be taken down and put up every year. Your Business Committee conferred with the Finance Committee and the result was we bought from the Edison Electric Company at a reasonable figure—we think—all the material on the ground pertaining to the electric department, at a cost of $3,149.08.

SEWER AND WATER.

At the January meeting, 1906, we were indebted to Watson Bros., $3,250.00. This amount has been settled, net $1,862.50. We have this year put into permanent improvements, sewer pipe and tile, $254.08; sanitary tank, $157.70; water tank, $300.00; pipe, fixtures and material for water and sewer, $338.41, or a total of $4,319.00.

ENGINE HOUSE.

We found it necessary in order to procure a fire engine on the ground, to construct a suitable building. Your committee has constructed such a building at a cost of $855.83.

BUILDINGS.

We found it necessary also to make improvements to our poultry building at a cost of $405.29. Improvements to other buildings as follows: lumber, $200.00; labor, $201.50; painting and repairing of Michigan building, $290.00. Total, 1,096.79.

SHRUBS AND TREES.

Carrying out the system of putting out shade trees on the different avenues, we let the contract to Mr. Louis Snell for $711.50, or $6 per tree, he to replace any trees that die, and also care for the trees for a certain length of time. We also paid for shrubs and trees to Inglefritz Sons & Co., $123.75; Ferrand Nursery Co., $27.55; Coryell Nursery Co., $46.50, or a total of $909.30.

IMPROVEMENTS TO GROUNDS.

We found at the close of the 1906 fair, that our grounds needed some improvements, also the track. We found in several places in the track, ground we had to remove and replace. I give you in a lump sum, as taken from our pay roll, the cost of planting, grading, work on walks, drives and track, $1.949.23. Paid for gravel, stone and cinders, $433.99, or a total of $2,383.22.

GRAND TRUNK SIDINGS.

You will possibly remember in the report of the president yesterday, the matter of sidings. Your committee took this up with the Grand Trunk people, and two additional sidings were put in at a contract price of $1,634.00. This amount was increased by extra work.

TEAMS AND TOOLS.

We found it necessary to buy a team and sundry tools. We did so at a cost for team of $400.00, harness and fixtures, $46.70; wagon, $42.10, or a total of $488.80.

FURNITURE AND FIXTURES.

We found our office minus any furniture and we have purchased as follows: typewriter desk, $23.52; office furniture, $98.50; three show cases at ground, $36.00; two cash bags for treasurer, $22.00; two window guards, $3.75; ticket boxes, $36.00, or a total of $219.77.

CARETAKER.

Your Business Committee found it difficult and expensive to hire day help to look after the grounds and has made a contract with one Frank Freegard of Pontiac at a cost of $700.00 a year, the society to furnish him a house, he to give his entire time to the society work.

We have been able to have two small buildings built on the grounds, at no cost to the society, one of them wholesaler of meats and provisions; the other creamery supplies. The buildings though small add about $1,000 to the grounds. I would say in connection with this,

we receive from these people five per cent of all sales which ran up this year to about $500.00.

In conclusion, I would state that there are many improvements necessary, but as long as finances are in their present condition, I think it better to defer all improvements. As one of your Business Committee, I would be in favor, if terms and arrangements could be made satisfactorily, that we lease, or contract with a proposed company or corporation to take over for a certain period of the year the grounds, or rather tracks and barns and procure needed improvements.

Thanking you gentlemen, for the support given me, I am,

Yours truly,

A. J. DOHERTY,

General Superintendent.

REPORT OF THE SECRETARY.

The Secretary reported entries and awards in the several divisions as follows:

Cattle—Number single entries, 791; number herds and sweepstakes, 260.

Amount awarded		$7,782 00
Less received Amer. S. H. B.	$670 50	
Less received Amer. Hereford	181 54	
Less received H. F. Assn.	75 00	
		927 04
Net paid by society		$6,855 96

Champion medals, 68.
Grand champion cups, 35.
Horses—Number of entries, 480; amount awarded, $3,166.00.
Cups, 11.
Sheep—Number single entries, 1,284; number herds and sweepstakes, 247; amount awarded, $4,026.00.
Medals, 88.
Cups, 44.
Swine—Number single entries, 655; number herds and sweepstakes, 187; amount awarded, $3,102.00.
Medals, 61.
Cups, 32.
Diplomas.
Poultry—Number entries, 1,680; amount awarded, $1,361.50.
Agricultural Department—Number entries, 682; amount awarded, $1,328.75.
Dairy—Number entries, 196; amount awarded, $362.94.
Apiary—Number entries, 52; amount awarded, $174.00.
Art—Number entries, 276; amount awarded, $401.50.
Needlework—Number entries, 787; amount awarded, $448.75
Educational—Number entries, 788; amount awarded, $1,014.00.
Horticulture—Number entries, 1,264; amount awarded, $1,825.25.

REPORT OF THE TREASURER.

Receipts deposited in bank		$157,731 09
Balance in Dime Savings Bank		20 38
By checks paid	$152,966 05	$157,751 47
Balance People's State Bank	4,766 04	
		157,732 09
		$19 38
Cash items, John McKay		114 50
Cash items, C. A. Floyd		145 68
Pay roll uncalled for		84 67
There are outstanding checks unpaid		$506 84

NOTE.—This report does not cover the transactions of the year, but only shows the condition of the Treasurer's account to January 1, 1908.

FINANCIAL STATEMENT FOR 1907.

RECEIPTS.

General gate admissions		$50,941 68
Railroad coupons		12,761 60
Grand stand, day	$9,353 75	
Grand stand, evening	8,313 25	
		17,667 00
Memberships		835 00
Rent grounds, motor and auto races		374 01
Privileges and concessions, all kinds		31,573 00
Races, entry fees	$2,754 00	
Per cent from M.	1,550 00	
Stall rents	296 55	
		4,600 55
Miscellaneous receipts, advertisement premium list		1,515 75
Stall rents	$895 65	
Short Horn B. Assn.	670 50	
Hereford C. B. Assn.	181 54	
Holstein F. Assn.	75 00	
Sundry	56 47	
		1,979 16
Total receipts of fair		$122,247 75
Appropriation from State		10,000 00
		$132,247 75

EXPENDITURES.

Office and salaries	$5,070 49
Printing and stationery	2,148 00
Advertising	8,310 69
Attractions	10,256 29
Races	11,241 19
Premiums including cups	27,068 37
Diplomas, ribbons, badges	319 55

Departments:		
Cattle	$189 53	
Horses	289 80	
Sheep	136 79	
Swine	170 55	
Poultry	158 00	
Agriculture	154 36	
Dairy	183 79	
Apiary	78 30	
Vehicle	63 43	
Implements and machinery	213 99	
Art	267 21	
Needlework	192 32	
Horticulture	232 32	
Educational	110 67	
Forage	66 46	
Mineral	125 15	
Gate, police and ticket	2,694 18	
Concession	2,179 31	
Reception committee	54 02	
Finance committee	248 38	
Business committee	957 27	
President's office	362 00	
Vice president's office	68 96	
Transportation	149 15	
Treasurer's office	814 22	
		$10,160 16
Maintenance buildings		1,195 21
Maintenance grounds		4,093 72
Interest		8,352 04
Insurance		2,932 88
Miscellaneous		4,347 04
Total expenditures pertaining to the fair		$95,495 63
Net profits for the year		26,752 12

PERMANENT IMPROVEMENTS.

(Added during 1899.)

House for fire department	$855 83
Electric lighting system	5,365 96
Sewer and water	4,300 19
Improvements to buildings	806 79
Turnstiles	671 09
Shrubs and trees	909 30
Grading and improving walks and drives	2,383 22
Team and tools	488 80
Furniture and fixtures	219 77
	$16,000 95

INDEBTEDNESS AT CLOSE OF 1907.

First mortgage bonds sold		$85,000 00
Notes secured by first mortgage bonds:		
Citizen's Bank, Romeo, due September, 1908	$5,000 00	
Caroline McKay	5,000 00	
John McKay	5,000 00	
		15,000 00
Total		$100,000 00
Notes covering floating indebtedness		85,259 18
Total indebtedness		$185,259 18

REPORTS OF EXECUTIVE SUPERINTENDENTS.

CATTLE.

To the President and Officers of the Michigan State Agricultural Society:

Your superintendent of cattle would offer the following report:

The year of 1907 would seem to make an epoch in the cattle exhibit at the Michigan State Fair. Not that it exceeded in numbers all previous shows or that every individual shown was better than those of other years, but taken as a whole, and giving consideration, the numbers, the uniform quality, and the fact that eighty-one per cent of the cattle on exhibition were Michigan cattle, and the further fact that eighty-six per cent of the money in the open class was won by Michigan cattle.

These facts of which all Michigan men may be proud are an evidence that Michigan is taking the place as a producer of high class cattle to which she is justly entitled.

To make special mention of individual exhibits in this report would be well nigh impossible but it will perhaps suffice to say that almost without exception the class of cattle shown at this exhibition was of the highest merit and the only regret is that we were not able to award prizes to all.

In numbers the Holsteins were in the lead with one hundred and thirty-four head from ten herds. Next came the Short Horns with one hundred twenty-six head of very high quality. Special mention should be made in this connection of one animal in particular shown in the dairy test by W. W. Collier of Detroit, a three year old Short Horn cow that should have won out in the special dairy test and would have done so except for technical rules by the American Short Horn Association governing these tests. She, however, made a good record and is but another instance of the value of the Short Horn as a dual purpose cow.

All breeds named in the premium list were represented. The Brown Swiss and Ayrshires, which heretofore have been absent, were out in good force. While we were short of room to care for all, the exhibitors were uniformly good natured and showed a disposition to put up with inconveniences. With the large cattle show that is likely to be made at our fair, there is need for still more room for housing them. Also provision should be made for room for food for the cattle, and also for bunks for the attendants where they have comfortable quarters without infringing on the space which should be occupied by cattle.

The question of the revision of the prize list is one that should receive careful attention by this board. That the double classification now existing is the subject of much annoyance and dissatisfaction is well known. Just what is best to do to remedy this evil is a question upon which we shall not all agree. After giving the matter careful attention and discussing it with many fair and exposition officials, and those who have long been in the show business, I am of the opinion that the best solution of the problem is the single class carrying the

cash prizes to at least the fourth and perhaps the fifth place, and removing all restrictions other than that of merit, except that only one prize should be awarded to a single exhibitor where there is no competition.

I am not at all sure that this remedy would be a panacea for all the ills of the prize list. I would be unalterably in favor of maintaining the prize list with the highest possible appropriation compatible with our financial conditions.

All of which is respectfully submitted,

C. A. TYLER,
Superintendent.

HORSE DEPARTMENT.

To the President and Officers of the Michigan State Agricultural Society:

Gentlemen:—The state fair of 1907 was honored with a most remarkable exhibition of horses, both in numbers and quality.

The different classes of horses received entries as follows:

Class 13—Standard Bred	43
Class 14—Non-standard	33
Class 15—Roadsters	52
Class 16—Saddle horses	38
Class 17—Carriage and coach	95
Class 18—American coach	2
Class 19—Hackneys	24
Class 20—French coach	0
Class 21—German coach	4
Class 22—Percherons	91
Class 23—Clydesdales	13
Class 24—Shires	9
Class 25—Belgians	15
Class 26—Grade draft	34
Class 27—Breeding Shetland ponies	50
Class 28—Jacks and mules	3
Total entries	506

Our total number of stalls was only 282, leaving a shortage of 224 stalls, thus emphasizing the pressing necessity of at once constructing barn room for the show horses.

The necessity for doubling our stabling capacity becomes imperative now that our fair will conflict with that of no other nearby state, except Wisconsin. Our show barn is conceded to be both beautiful and convenient; it might be extended in both parts on like plan a considerable distance towards the poultry house and I strongly urge that in addition thereto a pony barn be erected on a plan similar to the

one on the state fair grounds at Springfield, Ill., which is deemed the best pony barn in the United States. Such a barn would readily fill, and be the storm center of attraction of the entire fair. The stalls being made low and small, the ponies would show to their best advantage, but while housed in such stalls as we now have in our show barn, they are largely lost from view and the splendor that attaches to a first class pony show is largely lost. Again I urge the immediate construction of a pony barn.

I call your attention to another pressing need, which arises from the fact that many horses are required to show in harness or under saddle, yet we have no place whatever in which to store the harnesses, saddles and paraphernalia required, unless we give up horses' stalls for the purpose, which is not only contrary to the rules, but detracts largely from the beauty of the barn.

I had formerly urged that the class for coach horses be divided into three separate classes, namely: one for the American coach; one for the French, and one for the German. I had also urged that the classes for Shires and Clydes be separated for the reason that the owners of each regard his breed as a separate and distinct one, and nobody likes to show one breed of horses against another.

I also ask for a division of the Hackney Class, so that the Ponies or small Hackneys may be in a class by themselves and not be obliged to show against the large ones.

Again I call your attention to something that seems to me worthy of your consideration. I believe it desirable that the society should offer substantial premiums to photographers who shall take views on the grounds of animals and other exhibitions during the fairs; the society to select therefrom such photographs as it may desire for use in the next year's premium list, and also for free distribution to local newspapers, agricultural and live stock papers, from day to day, to the end that such papers may have on hand for use the best pictures obtainable on the grounds.

The judging of horses was done by a single judge, Dr. Donald G. Southerland of Saginaw, and I believe it was done as satisfactorily as it is ever likely to be done by any one judge or any number of judges.

In conclusion I congratulate the society on the marked success of its recent horse exhibition and express the belief that with adequate housing the number of show animals may be readily doubled, making the Michigan State Fair one of the greatest, if not the greatest horse exhibit in the Union. All of which is respectfully submitted,

L. C. HOLDEN,
Superintendent.

SPEED DEPARTMENT.

To the President, Officers and Members of the Executive Committee of the Michigan State Agricultural Society:

As superintendent of the speed department, I submit the following report:

In our premium list we offered stake races for two-year-old trotters and pacers, also for three-year-old trotters and pacers, none of which filled with the exception of one starter in the three-year-old trot, which was settled for $135.00.

We offered eighteen purses in the trotting and pacing classes of $500.00 each. The 2:11 trot did not fill, which left us seventeen races on our program. The 2:15 trot we declared off as we could not finish our program on Friday afternoon by having the trot.

In all the races of the Michigan State Agricultural Society with which I have been connected for the last twenty years we have never had a set of horses upon the fair grounds that were so unevenly matched as they were in these races.

I desire to call the attention of the committee to the condition of the track. It needs covering very badly. If we had a covering of suitable soil of three to four inches on the top of this track it would make one of the best tracks in the United States, and I believe it would be a source of revenue to the society, as by having the track fixed we could have a large number of horses working on the track the entire season.

In making out the attached statement showing the financial condition of the races, I have used one-half of the grand stand receipts for the afternoon of each day, and taken nothing to the credit of the horse department for entrance through our gates.

The receipts and disbursements are as follows:

RECEIPTS.

106 at $25.00 each	$2,650 00	
1 entry from three-year-old	6 00	
62 winners at $25.00 each	1,550 00	
Three-year-old purse unearned	300 00	
2:15 trot unearned	500 00	
Fourth money saved in free-for-all pace	50 00	
Fourth money saved in 2:22 trot	50 00	
		$5,106 00
The above receipts came into my hands during the fair and were turned over to the treasurer, for which I have his receipt.		
Received from colt stakes	$48 00	
Received from pool privilege	3,140 00	
One-half afternoon receipts, grand stand	4,676 87	
Stall rents	296 55	
Score card	450 00	
		8,611 42
Total receipts		$13,717 42
Total disbursements		10,304 89
		$3,412 53

Geo. A. Schneider, starting judge	$98 50
John Carmody, circuit agent	50 00
John Thompson, marshal	33 22
Geo. S. Ward, clerk	172 48
American Sportsman, advertisement	15 00
Horse Review, advertisement	18 15
Horse World, advertisement	15 00
Western Horseman, advertisement	12 39
Michigan Horseman, advertisement	10 00
Chicago Horseman, advertisement	15 00
Canadian Sportsman	10 00
J. F. Rundel, assistant	73 55
American Trotting Association, membership	75 00
Michigan T. & P. Circuit	5 00
Frank S. Cook, advertising agent	20 00
H. N. Williams, horse for marshal	15 00
Paid J. J. Kerby, first money, three-year-old trot	135 00
Wigle & Brown Spec. Race "Gallagher"	150 00
Track work during season:	
Frank Freegard, care of track to September 7th	348 97
Other work on track	43 83
Keep team to September 7th	115 80
Salary and expense, superintendent speed department	60 00
Flagman	9 00
Judges' lunches	4 00
Money drawn by me from treasurer to pay speed purses	8,800 00
Total	$10,304 89

Respectfully submitted,
EUGENE FIFIELD,
Superintendent.

SHEEP DEPARTMENT.

Mr. President and Members of the Executive Committee:

Gentlemen: As superintendent of sheep at your splendid state fair of 1907, I beg to submit the following report:

If permissible from one not a member of your honorable board, I would suggest that owing to the large number of the exhibits in this department and knowing of no reason why in years to come there will be any great falling off in entries in this department so that you will not be confronted with empty pens, I can see no harm in making a reasonable charge above your now merely nominal pen rental for sheep that are brought out for sale rather than as show sheep. If practical, would have pens assigned in order of receipt of entries.

Wishing to thank you all, exhibitors as well, and the Business Committee especially for the many kindnesses shown, all of which is respectfully submitted,

W. E. BOYDEN,
Superintendent.

SWINE DEPARTMENT.

To the President and members of the Executive Committee of the Michigan State Fair:

Gentlemen: As superintendent of swine, I beg to submit the following report:

Whole number of swine exhibited, 655:	
Amount of premiums offered	$5,140.00
Amount of premiums awarded	3,102.00

The show as a whole was a very creditable one. The lack of pens was somewhat annoying to both exhibitors and superintendent but was gotten along with, without working any serious hardship to anyone. There was one protest made in Duroc Jersey class, which upon investigation was not sustained. I would suggest that where protests are made they should be accompanied by a suitable fee to cover cost of investigation and where same is not sustained, party making protest should not be reimbursed.

GEORGE KELLY,
Superintendent.

POULTRY DEPARTMENT.

Mr. F. Postal, President:

In accordance with the rules of the Michigan State Agricultural Society, I herewith submit to you my report with recommendations of the poultry department.

Birds on exhibit	2,163
Pigeons	68
Belgian hares	42
Total	2,273

RECOMMENDATIONS.

That the entry fee for single birds a charge of twenty-five cents be charged, and for pens, fifty cents; and increase premiums accordingly. By doing this I believe it would be the means of keeping out a lot of inferior birds and leave more room for better ones.

That a floor be put in the building. There are more people pass through this building than any other live stock exhibit, but the accommodations are poorer than any.

Respectfully submitted for your consideration,

D. THOMAS,
Superintendent.

AGRICULTURAL DEPARTMENT.

To the President and Executive Committee of the Michigan State Agricultural Society:

Gentlemen:—I report a large and fine exhibit in the department of agricultural products at the last fair. The entries were as follows:

Grains and seeds	210
Vegetables	327
Collections	32
County exhibits	11
Total	580

There were eight county exhibits and each was good.

The exhibit made by the Upper Peninsula Agricultural Association was the best yet made from the upper peninsula, and Mr. Geismar, the secretary, and Mr. Poe, the treasurer of that association, are entitled to much credit for the showing made.

The northern counties of the lower peninsula show continued interest in making exhibits and the variety and quality improve each year.

This department is greatly hampered by lack of space. The overflow from the building devoted to this department was placed under the grand stand to the great disadvantage of both the exhibitor and the show.

We need at least twice the space we now have, and without it we cannot increase or even hold the exhibits we have had for two years past.

I recommend that addition be made to the premium list for collection of greatest and best variety of potatoes from any county in the state, collected by society or individual, but all varieties in any one exhibit to be grown in one county.

First, second and third premiums; also a premium for forage and grain, plants growing in pots or boxes.

Collection—First, second and third premium.

The list as now published to remain with perhaps a few modifications which I may suggest to the premium list committee.

Respectfully submitted,

W. J. TERNEY,

Superintendent.

DAIRY AND DOMESTIC DEPARTMENT.

To the President and Executive Committee:

Gentlemen:—The exhibit in the dairy department of the fair of 1907 was larger than in 1906. The holding of the state butter scoring test at the fair adds largely to the number of exhibits and brings out the best in the state.

The same is true of the cheese. Michigan cheese seems to be the favorite, but there was a good exhibit of cheddar.

The creamery butter scored high, the highest being 97½.

Dairy butter scored well, and the score was quite even.

The total number of entries and the amount awarded in each class were as follows:

Cheese	53
Creamery butter	71
Dairy butter	16
Domestic Mfs.	56
Total entries	196

Amount awarded, $362.94.

The exhibits of fancy cheese and butter statuary made by Peter Smith & Sons were very fine and were made at large expense.

I recommend that a silver cup be awarded them for these exhibits.

Much more space is needed for the exhibit of dairy implements and supplies and the exhibitors are willing to pay for this space. I shall be glad to see the time when they can have it, as it affords interesting displays for visitors to examine.

The State Dairy and Food Department was with us as before and aided materially in the scoring tests and in chemical work.

Respectfully submitted,

L. W. SNELL,
Superintendent.

APIARY DEPARTMENT.

To the President and Members of the Executive Committee:

Gentlemen:—As superintendent of the apiarian department I submit the following report:

There were two exhibitors, C. M. Nichols Co., and M. H. Hunt & Son, both of whom made a very fine display of live bees and honey in its various forms, together with beeswax.

I find that a good many beekeepers object to making a display in the room under the grand stand with its present arrangement, as they claim

they are entitled to a building suitable for their purpose, but temporarily I think the present location could be arranged at a very little cost to suit the requirements, and would recommend improvements be made.

The apiarian department certainly attracted its share of attention from the visitors to the fair, and your superintendent finds that it is an industry to be fostered, one that the sale of its products puts a great many thousands of dollars of circulation throughout the state. Another season I am satisfied that with proper agitation a goodly number of exhibitors should be looked for, as the beekeepers certainly turned out in great numbers to the 1907 exhibit.

Respectfully submitted,
F. B. RANSFORD,
Superintendent.

IMPLEMENT AND MACHINERY DEPARTMENT.

To the Officers and Directors of the Michigan State Agricultural Society:

Gentlemen:—I beg to submit to you the following report of the department of implements and machinery of the fifty-eighth annual state fair of Michigan, held at Detroit, Aug. 29 to Sept. 6, 1907:

There were one hundred twenty-four entries in this department, but for various reasons but one hundred eleven individual exhibits were made. I am unable to furnish definite comparison with the showing made by my predecessor in this department at the fair of 1906, but from the best information obtainable there was a total of fifty-three entries in 1906. The total expense of running this department for the entire year 1907 was $126.64, as shown by the statement turned over to Secretary Butterfield, Sept. 15th last.

The matter of a permanent building for this department should be seriously considered by every member of our board. A structure might be built on the present implement space and devoted to the use of vehicle as well as implement exhibitors. Charging an annual rental, ranging from two to four cents per square foot (power furnished) for floor space in a building of the character proposed would provide a sufficient income to not only pay the interest on such a building investment, but would enable the society to make liberal payments on the original principal each year.

Assuring you of my best efforts and wishes tending towards the future success of the society, I am

Respectfully yours,
VINCENT V. GREEN,
Superintendent.

VEHICLE DEPARTMENT.

There was a large and valuable exhibit of vehicles by manufacturers of these goods.

A building in which to exhibit them is badly needed.

A. E. STEVENSON,
Superintendent.

ART DEPARTMENT.

To the Officers and Directors of the Michigan State Agricultural Society:

Gentlemen:—To sum up briefly the work of the art department at the state fair this year, there has been, I think, a better standard set and fewer objectionable features. The larger part of the walls were given up to a collection of paintings that were secured by personal request from artists of the better class, to whom an exhibition at a state fair does not appeal. Feeling that their pictures will hang side by side with the amateur, they will not enter into competition.

I am more strongly impressed than ever with the thought that before your society can hope to make a creditable showing in the art department there must be a suitable building, lighted from above, and reasonably fireproof. This need not be an expensive building, plain brick walls with rather an ornamental doorway would be quite sufficient, with an interior of the plainest and simplest character. It need not all be erected at once.

With such a building you could call upon the artists of Michigan—a state which has produced some of the great men of the art world—with the assurance that they would loyally respond, and pictures of merit could be brought together which would form one of the most attractive features of the fair.

I would suggest at the same time, that the pictures offered by the amateur have a good showing, as out of their ranks must come some of the future artists, but I would particularly encourage the art student to exhibit, so that the people may be brought in contact with the best development along art lines.

With more sincere good wishes for the continued success of the society, I am

Very truly yours,
A. H. GRIFFITH,
Superintendent.

NEEDLEWORK DEPARTMENT.

To the President and Members of the Michigan State Agricultural Society:

Your superintendent of needlework begs leave to offer the following report:

The exhibition in the needlework department at the Michigan state fair in 1907 was certainly a very pleasing one, and it is gratifying indeed to note the number of entries made, and the superb quality of the articles displayed.

It is the belief of your superintendent that some additional inducements should be made to exhibitors in this department as rapidly as the financial condition of the society will admit.

A separate building for the exhibition of woman's handiwork with rest rooms, demonstration rooms, and assembly hall is an innovation that would meet with the approval of all. If at an early date it would be possible to provide some kind of protection such as glass front cases, whereby we could make each exhibitor more secure from loss or injury to their delicate articles of handiwork, I am sure it would have the effect of bringing out a greater display, and also additional quality.

I would urge upon your honorable board that something of this kind be provided as soon as it is expedient.

The entries in this department this year numbered 787. The total value of these articles would run well into the thousands of dollars. This can readily be doubled with adequate provision for the protection of at least the finer articles.

The entire expense for conducting this department during the fair was $189.00. Your superintendent took active campaign for exhibits, having written over one hundred personal letters, and making many calls, and the only rebuffs received were on the ground of insufficient protection for the dainty exhibits.

Wishing in this connection to thank the officials of the society and especially Secretary Butterfield for the uniform courtesy shown the superintendent of this department, this report is respectfully submitted.

BELLE F. CLARK,
Superintendent.

HORTICULTURAL DEPARTMENT.

To the President and Members of the Michigan State Agricultural Society:

Gentlemen:—When the work of securing a horticultural exhibit was taken up, two difficulties were experienced: First, the almost total failure of the fruit crop in most of the southern counties; second, the early date at which the fair was held combined with the lateness of the season, making it difficult to secure anything like the full size and high color which are necessary for an attractive exhibit of fruit, especially as most of the fruit had to come from the northern part of the state.

Several of the counties which had planned to make exhibits, notably Van Buren, Grand Traverse, Eaton and Macomb, found it practically impossible to secure a creditable display, while Allegan and Kent sent much smaller amounts than they had planned for. It was found, too, that, in several of the northern counties from which the expenses of making the exhibits have in the past been paid by appropriations by the boards of supervisors, no provision for anything of the kind was made this year. As I understand it, this was the case in Cheboygan, Ogemaw, Alcona and Crawford counties, and I would recommend that steps be taken previous to the annual meetings of the supervisors to secure such appropriations for the coming year.

Considering the drawbacks mentioned above, very creditable exhibits of fruit were made by Roscommon and Otsego counties in the northern section; by Clare, Emmet, Charlevoix, Leelanau and Benzie counties in the northwestern section; by Oceana, Kent and Allegan counties in the southwest and by Washtenaw and Bay counties in the southeast section. Fruit from several other counties was on exhibition. The fruit from Oceana, Kent, Allegan and Leelanau counties was especially noticeable for its freedom from the attack of the various insects and diseases to which it is subject, due to thorough spraying. The exhibits compared well in extent with those of any previous year and only lacked in size and color. The peaches and plums were as fine as were ever shown at the state fair except that the later kinds were only partially developed.

The exhibit of canned and preserved fruit was slightly larger than in 1906, and was very tastefully arranged by Mrs. Hoffman, who also had charge of the cut flower exhibit. The judges found little or no adulteration, and the appearance and condition of the fruit, pickles and jellies spoke highly of the ability along this line, of the various ladies who furnished it.

The greenhouse plants on exhibition for premiums were slightly in excess of those shown in 1906, both in quantity and quality. The building could readily accommodate double the number of plants shown this year, but it cannot be very much increased unless larger premiums are offered, as the Detroit florists claim that the present premiums do not recompense them for the labor expended when they take into consideration the injury sustained by the plants.

A load of plants from the Belle Isle conservatory, procured through the kindness of Park Commissioner Breitmeyer and Superintendent Unger, aided materially in decorating Horticultural Hall, and as they were of rare species and were specially selected on account of some striking peculiarity, or their economic value, they attracted much attention.

The cut flower exhibit, although not extensive, was of unusual merit. The exhibit of gladioli from W. F. Bole, Ada, was the finest ever made in the state, and exhibits by amateurs were excellent.

In the way of bedding plants, there was but one exhibitor for premiums, but he had entries in most of the classes. The appearance of the grounds was greatly enhanced by the large beds of cannas, salvias and roses, the plants for which were furnished gratuitously by Vaughan's seed store of Chicago, and by other plants furnished at a merely nominal price by Nathan Smith & Son, of Adrian. The exhibits of the various nursery firms also added materially to the appearance of that portion of the grounds.

As was the case in 1906, the Agricultural College occupied one corner of the Horticultural Hall with a very interesting and instructive exhibit, designed not only to illustrate the work of the college, and its equipment, but much of the exhibit was educational in its character, and those in charge were kept busy explaining it and answering questions.

I was fortunate in being able to secure Mr. M. L. Dean as judge of the fruit exhibit. Mr. Dean also proved very helpful in assisting the exhibitors in classifying and naming their fruit. Mr. Frank Holzbagle and H. W. Unger acted as judges of the cut flowers and plants, respectively. Prof. F. W. Robison was the judge of the canned fruit display, and all of them gave good satisfaction.

For financial statement see report of the secretary.

Respectfully submitted,

L. R. TAFT,

Superintendent.

EDUCATIONAL DEPARTMENT.

To the Honorable Board of Directors of the Michigan Agricultural Society:

It gives me much pleasure to submit the following report of the educational department of the state fair, held at Detroit Aug. 29 to Sept. 6, 1907:

The educational department was a success, many of our largest and best city schools sending very creditable exhibits. Among the cities to be remembered for the fine exhibits are Detroit, Pontiac, Bay City, Calumet, Ironwood, Saginaw, Romeo and Wyandotte. A number of the small village schools of the state made very fine exhibits also.

The premium list was arranged in the following departments: High school, grammar, intermediate, primary, kindergarten, music, manual

training, village and district schools. The different departments or classes were mostly well filled.

There was a total award of $956 in the educational department. The total cost of conducting the department for the year, including the judges and sending premium list to cities, villages and commissioners of schools having charge of district schools, etc., amounts to about $110. Hence it cost the Michigan State Agricultural Society a total of about $1,060 to maintain the educational department.

RECOMMENDATIONS OF THE DEPARTMENT.

Many more schools in city, village and district would be glad to arrange an exhibit if they could have the premium list earlier in the year, and with this in mind and knowing it to be so, I would first recommend that the premium list be published not later than December 1.

During our stay in Detroit our exhibit has been limited for space, so that many of the exhibits could not be shown at all.

Many will not send exhibits because they get so soiled and many are spoiled. If we had glass front cases we could get many better exhibits than we do now, and we would gain twice the space in the same room that we have now.

I would second recommend that some system of glass cases be installed for the better preservation of the exhibits and economizing space and this would also give us a place so the manual training exhibit would be more secure and free from being handled.

With these two recommendations it gives me pleasure to submit this as a report of the educational department of the Michigan state fair held at Detroit Aug. 29th-Sept. 6th.

Respectfully submitted,
THOS. M. SATTLER,
Asst. Superintendent.

FORAGE DEPARTMENT.

To the Officers and Members of the Michigan State Agricultural Society:

I herewith submit the following as the report for my department for the year 1907:

The forage for the fair was furnished by the North Branch Produce Company under arrangements made by the business committee, the details of which I presume will show in their report. The hay, straw and grain furnished was of a good quality and the patrons of the fair were well pleased with the treatment they received and everybody appeared to be satisfied.

All of which is respectfully submitted.

WM. DAWSON,
Superintendent.

MINERALS.

The mineral exhibit at the state fair of 1907 was much more elaborate and comprehensive than was that of the previous year, and was visited by a great many more people. Our experience in 1906 enabled us to be prepared with a better and more pleasing exhibit than we had in that year. The display of minerals, combined with the mining implements formed one of the chief features of the fair, and proved a great attraction for thousands of visitors.

An effort was made to make the exhibit partly economic and educational, as well as pleasing, and in this we were certainly successful. From the opening to the close of the fair, the Michigan building, in which the mineral exhibit was placed, was thronged with interested spectators, who made many inquiries regarding the nature and value of the minerals.

Beside the minerals and curiosities, the exhibits embraced a perfect working model of the skip and automatic dump, in active operation at the No. 2 shaft of the Allouez mine.

There was also a Rand-Ingersoll drilling machine of great power and efficiency in the exhibit, in perfect working order. In this exhibit was illustrated in a limited way the evolution of the mine drill. The appliances shown are exactly the same kind as are used every day in the mining of copper and iron ore, the chief mineral products of Michigan.

The mineral exhibit of 1907, I am sure, gave great satisfaction to the people who visited the fair. Not a single one went away dissatisfied. We tried to make the exhibit interesting, attractive and educational, and we think we succeeded in doing so.

Signed,
J. L. NANKERVIS,
In charge.

TRANSPORTATION.

Mr. D. R. Hurst was employed to superintend freight transportation to and from the fair. He succeeded in securing the unloading of exhibits promptly, and to the satisfaction of exhibitors. Also in the final task, that of reloading after the fair, he was able to assist both the railroad operators and the exhibitors and the exhibits were promptly loaded and dispatched to their several destinations.

Mr. John P. Kilcline, who assisted and had charge of a large part of the detail work, did excellent service in looking after delayed cars and packages less than car lots.

The passenger transportation was well performed by the Detroit United Railway, who carried the large number of passengers to and from the fair without delay or accident of any kind.

Mr. Terney presented a petition from the exhibitors and others for more space for the exhibits in the agricultural department.

On motion of Mr. Snell, a silver cup was awarded Peter Smith & Sons for their exhibit of fancy cheese in the dairy building.

The resignation of Mr. J. F. Brand, as member of the executive committee, was received and accepted.

Mr. Watkins nominated T. F. Marston, of Bay county, to fill the vacancy.

On motion of Mr. Watkins, the secretary was instructed to cast the ballot of the committee for Mr. Marston. Ballot so cast and Mr. Marston declared elected.

On motion of Mr. Aitken, the fees for stalls and pens were made as follows:

Single stalls for cattle, each 4 feet space......	$1 00
Single stalls for horses, each.................	1 00
Box stalls for horses, each....................	3 00
Pens for sheep and swine, each.................	1 00
Poultry, each single bird......................	25
Poultry, each breeding pen.....................	50

On motion of Mr. Aitken, a committee on premium list of seven members was appointed by the president, and the committee was instructed to prepare a list and present to the business committee and when approved by the business committee to be published as the premium list of the society for 1908.

On motion of Mr. Fifield, the amount of speed purses and schedule of races was left with the premium list committee.

On motion of Mr. Stevenson, the assignment of grounds and space for the several departments was left with the general superintendent.

On motion of Mr. Aitken, the leasing of the track and speed stalls to an association for a term of years, was referred to the business committee.

On motion of Mr. Aitken, the business committee was instructed to appoint a competent person who shall be an assistant to the general superintendent and who shall have charge of all complimentary admissions and free passes of all kinds and shall issue the same under instructions and regulations made by the business committee, but such complimentaries shall be issued only in the interest of the fair and only to persons who may have performed some service to the society.

Mr. Tyler, by request of the president, presented the matter of inviting the American Rambouillet Sheep Breeders' Association to hold their annual meeting and sale on the fair grounds in 1908.

On motion of Mr. Tyler, the following preamble and resolution was adopted:

Whereas, The American Rambouillet Sheep Breeders' Association, having for some years past held the annual meeting of the association and maintaining a large and increasingly popular public sale of the best selections of their breed, and also offering attractively large special prizes, aggregating one thousand dollars or more, in connection with the regular classification of the International Live Stock Exposition at Chicago; and

Whereas, We have positive information that said association is seriously contemplating transferring these functions to some centrally located fair or exposition, the dates of which are some months earlier than those of the International, thereby increasing the popularity and utility of their sale; and

Whereas, We believe the Michigan State Fair to be the best located and the best equipped for holding their sale and exhibition; therefore be it

Resolved, That the Michigan State Agricultural Society hereby extend to said association at a most cordial invitation to transfer these several feature to the Michigan State Fair of Detroit, and we hereby pledge to them our hearty cooperation, and every consideration consistent with a sound business policy; be it further

Resolved, That the President of this society appoint a committee of one or more at his discretion to negotiate with said association and that said committee shall, by and with the advice and consent of the business committee, have power to act.

On motion of Mr. Aitken, the sale of admission tickets previous to the fair was left with the business committee with authority to sell such tickets at the rate of three for one dollar, under such restrictions as may be thought desirable by the committee.

On motion the business committee was authorized to appoint a suitable person as business manager, who shall have charge of such detail work as may be assigned by the committee.

The premium list being under discussion, it was resolved that it is the sense of the executive committee that but one class be made for each breed in all the live stock divisions in the premium list.

On motion of Mr. Galbraith, the dates of the fair were fixed for Sept. 3rd to 11th inclusive, except Sunday.

It was resolved that the secretary be reimbursed to the amount of $239.00 loss, by theft, of money belonging to the society.

On motion the secretary was instructed to cast the ballot of the committee for A. J. Doherty for general superintendent. Ballot so cast and Mr. Doherty elected.

On motion the secretary was directed to cast the ballot of the committee for Lawrence W. Snell for member of the business committee.

Ballot so cast and Mr. Snell declared elected member of the business committee.

On motion of Mr. Aitken, the by-laws were amended with reference to manner of drawing checks to pay vouchers so that they may be paid by check drawn on the treasurer by the secretary and countersigned by the general superintendent.

The president announced the following committees:

Rules—Galbraith, Edwards, Green.

Premium List—Fifield, Collier, Peek, Aitken, Taft, Postal, Butterfield.

Program—Tyler, Watkins, Peek, Edwards, Marston.

Reception—Rich, Horton, President.

Finance—Aitken, Fifield, Marston.

SUPERINTENDENTS OF DEPARTMENTS.

Cattle—C. A. Tyler.

Horses—L. W. Watkins.

Speed—Eugene Fifield.

Swine—Geo. Kelly.
Poultry—Daniel Thomas.
Agricultural Products—W. J. Terney.
Dairy—Lawrence W. Snell.
Apiary—F. B. Ransford.
Vehicles—A. E. Stevenson.
Forage—Wm. Dawson.
Implements and machinery—V. V. Green.
Main building—N. J. Whelan.
Art—A. H. Griffith.
Needlework—Mrs. Belle F. Clark.
Horticultural—L. R. Taft.
Educational—L. C. Holden; assistant, Thos. M. Sattler.
Mineral—W. J. Galbraith.
Transportation—Chas. L. Edwards.
Chief marshal and police—A. J. Peek.
General superintendent—A. J. Doherty.
Concessions—The business committee.

Mr. Collier moved that the daily program be posted on boards at the entrance gates.

The secretary reported withholding the first premium award in roadster class pair trotters on account of infraction of the rules.

It was moved that the premium be allowed. After discussion the motion was withdrawn and Mr. Holden moved that Mr. I. M. Bowers be allowed thirty dollars for services. Mr. Collier moved that it be fifteen dollars. Mr. Fifield demanded a call of the roll. Pending the roll call, a point of order was raised that a quorum was not present.

A count showed less than a quorum. On motion the executive committee adjourned.

I. H. BUTTERFIELD,
Secretary.

REPORT OF THE MICHIGAN STATE ASSOCIATION FARMERS' CLUBS FOR THE YEAR ENDING JUNE 30, 1908.

The annual meeting of 1907 was held at its home, the senate chamber, December 10 and 11, 1907.

Ninety-eight delegates represented sixty-five clubs. Eighty-two clubs are now paying members to the State Association, and the revised list of clubs gives 128 clubs in the state in thirty-two counties, with 8,000 members.

One hundred report blanks were returned and the statistics compiled by the secretary are as follows:

Nine hundred ninety-three meetings were held, with an average attendance of 45.

Twenty-one clubs have yearly programs.

Fifty-two clubs have an annual picnic.

Twenty-two clubs held fairs.

Sixteen clubs held a temperance meeting.

Fifty-six clubs discussed the associational question.

Eighty-three deaths occurred.

Forty-seven clubs sent their monthly report of meeting to the Michigan Farmer.

The program was one of unusual interest. The following addresses were given:

"The Relationship Between the Farmer and the Railroad," C. L. Glasgow.

"The Temperance Question," Geo. W. Marrow.

"Centralization of Schools," Prof. T. M. Sattler.

"Home Sanitation as Applied to Farm Life," Dr. F. W. Shumway.

"Some Neglected Horticulture Opportunities," C. E. Bassett.

"The State Fair and What of the Future," I. H. Butterfield.

"Duties and Rights of the Farmer to the Public," H. S. Earle.

The conference of local club workers is no small part of the annual program. This was in charge of Director J. P. King, of Marshall.

The election of officers resulted as follows:

President—A. L. Chandler, Owosso.

Vice-President—J. P. King, Marshall.

Secretary—Mrs. W. L. Cheney, Mason.

Treasurer—A. C. Patterson, Pittsford.

Secretary of Club Extension—Col. L. H. Ives, Mason.

Directors—W. A. Reed, Hanover; F. D. Clark, Vernon; D. M. Beckwith, Howell; D. M. Garner, Davisburg; T. B. Halladay, Norvell; E. C. Hallock, Almont.

MRS. W. L. CHENEY,
Secretary.

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